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THE WASTE OF LIFE IN AMERICAN COAL MINING

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It is not necessary to emphasize the urgent importance of this theme, nor indeed possible to point its significance more impressively than the authors do in the opening sentence. We are glad to be able to present so authoritative a discussion of the situation as it exists and of the possibilities of betterment—a discussion based upon the careful studies and the exhaustive data assembled during many months work by the explosives expert and the explosives chemist of the United States Geological Survey. To them and to the Director our acknowledgements are made for this special presentation of their conclusions in our pages.—THE EDITORS.

THE four recent mine disasters in the United States, with the loss of nearly one thousand lives, have given terrible point to the bulletin just issued by the Technologic Branch of the United States Geological Survey on "Coal Mine Accidents, Their Causes and Prevention." The figures given in this report indicate that during the year 1906 nearly seven thousand men were killed or injured in the coal mines of the United States, and that the number of these accidents caused directly or indirectly by mine explosions has been steadily increasing. It is also indicated that this increase has been due in part to the lack of proper and enforceable mine regulations; in part to the lack of reliable information concerning the explosives used in mining, and the conditions under which they can be used safely in the presence of the gas and dust encountered in the mines; and in part to the fact that in the development of coal mining not only is the number of miners increasing, but many areas from which coal is being taken are either deeper or farther from the entrance, where good ventilation is more difficult and the dangerous accumulations of explosive gas are more frequent.

The increase both in the number and the seriousness of mine explosions in the United States during past years may be expected to continue unless the country adopts means that have proved successful in European countries, where the proportionate death rate in the mines has been materially reduced. Information is needed at once concerning the explosives used in the mines, the conditions under which they may be used safely in the presence of coal dust and gas, and the general conditions which make for health and safety in coal-mine operations. In 1906 the total number of men killed in the mines was 2,061, and the injured 4,800. In 17 years 22,840 men have been killed in the coal mines of the United States. In 1890 the number killed was 701. The number of killed has steadily increased until 1905, when 2,097 met with violent deaths. The great increase in the production of coal during the last decade and the related increase in the number of men employed in the industry do not account altogether for the increase in the number of fatal accidents, although this may seem to be true. In 1895 2.67 persons were killed in the coal mines for each 1,000 men employed. This ratio has increased until in 1906 it reached 3.40, and this was exceeded in 1905 and 1902. In all the European coal-producing countries, the output of coal has greatly increased during the last 10 years, but the number of deaths per 1,000 miners, instead of increasing as in America, has undergone a marked and decided decrease. This has been due to the effect of mining legislation in those countries for the safeguarding and protection of the lives of the workmen, and has been made possible by Government action in establishing testing stations for the study of problems relative to safety in mining, including the use of explosives.

In Belgium between 1831-40 before the testing station was built the average number of men killed per each 1,000 men employed was 3.19. From 1901-1906 this ratio had been reduced to 1.02. This is one-third of the ratio now existing in the United States. The beneficial result of this testing station is seen in the fact that the number of lives lost in the Belgian mines for each 1,000 men employed in 1906 was 0.94, while in 1895 the ratio was 1.40. Great Britain has reduced its ratio of 1.50 in 1891 to 1.29 in 1906. In Prussia the ratio of deaths per 1,000 men employed has decreased from 2.94 in 1880 to 1.80 in 1904. France's ratio has dropped in five years from 1.03 per 1,000 men employed to 0.84.

In the following tables giving the average ratio for the last period of five years for which statistics are at hand, the position of

the United States may be compared with that of the principal European coal-producing countries.

NUMBER OF MEN KILLED FOR EACH 1,000 MEN EMPLOYED—AVERAGES FOR FIVE YEARS.

France (1901-1905)	0.91
Belgium (1902-1906)	1.00
Great Britain (1902-1906)	1.28
Prussia (1900-1904)	2.06
United States (1902-1906)	3.39

CAUSES OF MINE ACCIDENTS.

Fifty per cent of all the fatal accidents and 39 per cent of all the non-fatal accidents in the United States were the result of falls of roof and coal. The following statement of deaths from this cause per 1,000 men employed shows how the United States compares with several of the European coal-producing countries in this respect.

DEATHS FROM FALLS OF ROOF AND COAL PER 1,000 MEN EMPLOYED.

Belgium	0.40
France	0.47
Great Britain	0.64
Germany	0.92
United States	1.70

In France, taking five-year periods, the number of men killed from falls of roof and coal for each 1,000 men employed has been reduced from a ratio of 1.26 in 1875 to 0.47 in 1900. In Belgium the number of men killed from falls of roof and coal for each 1,000 employed has been reduced from 0.998 in 1860 to 0.406 in 1904. In Great Britain and Germany the results are similar to those in France and Belgium. In all the European coal-producing countries the use of excessive charges of explosives is prohibited by law and definite limits are set as to the amount of any explosive that may be used. Although these regulations were framed with the object of preventing gas explosions, it is believed that they have been of marked effect in preventing accidents from falls of roof and coal, as the very great disturbing and jarring effect exerted by the discharge of large amounts of explosives in a mine is believed to be one of the most important causes of fall of roof. The actual fall of the rock or coal may not occur at the time of firing the charge, but the heavy shots weaken the wall and roof and start cracks that impair the support of the roof, so that months after the blast, without warning, it falls.

It is also to be noted that explosions of fire damp and coal dust have a similar effect in jarring and weakening the walls and roof, and in gassy regions, where small explosions of fire damp are of frequent occurrence, falls from this cause may make up a considerable

percentage of the total number. But even in such regions the use of explosives and of unsatisfactory forms of lamps is generally the indirect cause of the fall, for nearly all explosions of fire damp are caused by ignition from the shots used in breaking out the coal or from naked lights used by the miners.

In all European countries from which statistics are available restrictions in the maximum amount of explosives allowed to be used have not only increased the safety from explosions of gas, but have also materially diminished the loss of life due to falls of roof.

In the United States, during 1906, 11 per cent of the deaths in coal mines were due to gas and dust explosions. In Belgium the number of men killed in explosions of fire damp for each 1,000 men employed has been reduced from 0.965 in 1840 to 0.039 in 1904. The present death rate from these causes is about one-tenth of that of 30 years ago. This has been due to systematic testing of safety lamps, only those forms being allowed to be used which are capable of withstanding rapidly moving currents of fire damp under all conditions likely to be encountered in mines, and to a thorough testing of all explosives to determine the amount of each which can be fired without danger of explosions of fire damp or coal dust.

When the total number of fatal accidents in the coal mines of the United States is considered, with reference to the number of tons produced, it is seen that the number of men killed for each 1,000,000 tons of coal produced has not changed materially in the last fifteen years. Considered in periods the average results obtained are as follows:—

NUMBER OF MEN KILLED IN THE COAL MINES OF THE UNITED STATES FOR EACH MILLION TONS OF COAL PRODUCED, BY PERIODS.

General average, 1890-1906	5.93
1890-1895	5.97
1895-1900	5.77
1901-1906	6.04

In Great Britain in the decade 1874-1883 the number of men killed in the coal mines for each million tons of coal produced was 7.42. This has been reduced to the ratio of 4.31 in 1906. In France in 1900 the number of men killed for each million tons of coal produced was 5.55. In 1905 this was reduced to 4.17, but probably the 1906 ratio was larger. In Belgium in 1895 the number of men killed per each million tons of coal produced was 7.70. In 1906 this had been reduced to 4.96.

These figures show in regard to deaths per million tons of coal that the United States not only occupies a position worse than most

European countries, but also shows a general increase in the rate, whereas every other country has shown a decrease. This situation is still worse when it is considered that the natural conditions in America for getting out coal with the minimum amount of danger to the workmen employed are as favorable as in any other country in the world. With the depletion of the thicker and more favorably mined seams of coal, thinner and less regular seams must be worked. This will undoubtedly be a most important change within a comparatively few years, and the natural result would be to increase the death rate greatly. With the mining of the small beds of coal and the gradual development of properties worked with more difficulty, bringing the mining conditions in the United States more nearly to a position of equality with those elsewhere, a great increase in accidents must be expected, unless proper steps are taken to remedy the conditions which have brought about the remarkably high death rates in the coal mines of the United States. An important feature which must be considered in the mine accidents of the United States is the nationality of the miners. Most of them are foreign-born. A large proportion of them are unable to understand English freely, and a still larger number are unable to read or write that language. Some of them are inexperienced and do not take proper precautions for their own safety or for the safety of others. This becomes a most serious menace unless they are restrained by carefully enforced regulations.

Prevention of Mine Accidents.

In a number of European countries the Government is maintaining testing stations at which all the investigations into the use of explosives are conducted. These testing stations have already arrived at certain definite conclusions. The compulsory use of safety lamps in mines having a large amount of fire damp is general in all European coal-producing countries. The keeping of at least two safety lamps in a mine (whether thought to be gaseous or not) is also required in some countries; laws regulating the locking of safety lamps and requiring that all lamps should be capable of being so locked by magnetic devices, compressed air, or other means, as not to be opened by any other person, are also in effect. The employment of relighting stations, at which locked safety lamps may be relighted in a mine when they are accidentally extinguished, is permitted in several countries. In Germany the lamps in use are equipped with relighting devices of approved design and are known to be practically free from danger of igniting fire damp, so that re-

lighting stations are unnecessary. In the United States in many mines the safety-lamp provision is violated.

In all European coal-producing countries regulations have been made forbidding the use of such explosives as are known to be liable to ignite fire damp, in all mines in which fire damp is represented to be present to a dangerous extent. In the United States in a few States the mine inspectors have control over the amount of explosives used.

In England a list of "permitted explosives" is kept, including all those explosives that answer the required tests; and all explosives used in mines that are dangerous because of gas or coal dust must be selected from the permitted list, which now includes more than fifty explosives. Control of like kind is exercised in France, Belgium and Germany. In all these countries, the restriction of unsafe explosives has caused the development of "safety" explosives which have proved greatly superior to those previously in use. In Belgium, owing to the greater amount of fire damp present in the mines of that country, a further restriction known as the "charge limit" has also been put in force. Through this restriction the maximum amount of any explosive which is allowed to be used in any one single charge is defined. The actual amount allowed varies according to the liability of the explosive to ignite fire damp, but with all the better class of explosives it is well above the amount needed for use in a single charge under proper mining conditions. These restrictions in the kind and amount of explosives have yielded additional benefit in the fact that the reduction in the amount used not only reduces the number of accidents, but also to a large degree prevents coal waste. In the United States there is no limit set as to the amount of explosives to be used.

Regulations governing the storage of explosives for use in coal mines are in general effect in European coal-producing countries; they provide that no explosives shall be taken into a mine except in canisters containing not more than five pounds, and that no unused powder shall be left in a mine over night. The amount of powder in the possession of a workman at any one time is also limited, and the amount which can be taken into a mine is usually restricted to that which will be used in one shift. Regulations enforced in Great Britain provide that in all mines in which inflammable gas is present, or has been found in dangerous quantities within the previous three months, all charges of explosives shall be fired by a competent person termed a "shot firer." The object is to place the responsibility in

the hands of men better qualified for the work than the average miner. The shot firer begins work after the miners have left for the day, each miner on leaving having prepared the proper number of holes in the places where he wishes charges to be fired. The shot firer charges the holes with explosive and tamps and fires the charges. It will be seen that by this method the charges are fired at a time when but few men are in the mine, and that accordingly if a fire-damp explosion occurs fewer lives will be lost than if the miner fired his shots at a time when other miners were in the workings.

Still another factor of greater importance is that the shot firer, through constant experience, soon becomes used to the proper use of explosives, and also learns to charge the holes and fire them in the safest way possible. The shot firer is also free from the temptation to use excessive charges in the desire to get out a great amount of coal with the least possible effort. It is well-known to all persons experienced in coal mining that overcharging of holes and mining by means of large shots fired in the solid mass of coal bring about many fire-damp and coal-dust explosions.

At the present time several electrical shot-firing devices are being tested with promise of effecting a considerable saving of life. The main principle of these devices is the firing of the charges one after another, at proper time intervals. As already stated, the firing of the charges takes place after the miners have left for the day, and the entire operation of the device is automatic. It is of course necessary, after the charges are fired, to have some one examine each room in which a shot has been fired to see that conditions are normal, and that no feeders of gas have been ignited which might start a mine fire. The use of shot-firing devices or some other means equally safe is required by regulation in Great Britain.

The watering of the sides and roof of coal-mine passageways has been found to be of material benefit in preventing local ignitions of coal dust from becoming general. The watering prevents the coal dust from being stirred up by small explosions, and the reduction in the explosive properties of the wet coal dust has the general result of preventing an explosion from traveling into other workings. The watering is effected by sprinkling or spraying devices of various kinds.

The mining regulations of Germany, France, or Belgium, require that mines shall be supplied with means for administering to the comfort of injured workmen and that proper appliances shall be provided for first aid. Rescue devices equipped with small tanks of

compressed air, or compressed oxygen, or with some chemical appliance for generating a supply of oxygen so as to enable a person to enter a mine working in which an irrespirable atmosphere is present, are required in some countries. By the aid of such apparatus rescue parties may enter the mine working immediately after the fire-damp disaster and rescue injured miners who would soon fall victims to the poisonous atmosphere surrounding them.

Enforcement of Regulations.

In all European countries, the enforcement of regulations in regard to coal-mining operations is placed in the hands of a specially appointed force of mine inspectors, familiar with the industry and able to examine mine conditions intelligently and to see that the mining laws are obeyed. In the United States the mines are within the jurisdiction of the States which actually produce the coal, each State having a code of its own, the laws being different in different States. In Germany mines are under the control of the district officers, the superior mine offices, and the Minister of Commerce and Trade. The district officers are the first instance in all those affairs that belong to the mine authorities and which are not expressly turned over to the superior mine offices. The management of the extensive mining police is their most important charge. The district officers have under them the inspectors. Each inspector controls several mines which he has to inspect, reporting to the Department of Mines within a certain time. Especially dangerous mines are to be visited oftener than others. The inspection takes place at any time, night or day, usually without previous notice. Inspectors are authorized to call the attention of the employees of the mining company to certain offences against the mining police regulations and to other bad conditions, and to talk over improvements with them. Several functions are imposed upon the district officers by the local police authorities, the lower administration authorities, and the industrial chambers of mines, which give them a great influence upon the affairs of the workmen. Superior to the district officers are the superior mine offices, which hold the rights of the government within the territory. They are tribunals of first instance in all matters and also for appeals and plans. The most important right given to the superior mine offices as a mine-policing authority is the right of issuing independently police orders and police directions on the basis of the common mining law. To carry on the business of the third instance (being chiefly the instance of appeals) there has been estab-

lished in the Department of Commerce and Trade a Department of Mines, Smelting, and Saline Works, which is presided over by the superior mine captain. In order to ensure the successful control according to the Government mining law, the law imposes upon the owner the following duties as being an important foundation:—at least four weeks' notice to the mining authorities regarding the starting of work order or stopping of mine; and the operation of the mine only under the superintendence of persons who have been recognized by the authorities to be capable. The mine owner is bound to have made, by a recognized surveyor, a plan of the mine in duplicate, and to have made in due time all additional entries in the same. One of the plans is filed by the mining authorities for their use. The mining authorities may stop the work, carry out their directions by a third person at the expense of the mine owners, inflict fines, and withdraw the right to conduct and control the mine. Stopping of work can be ordered by a district officer either for a whole mine or for parts of the same for the following reasons:—when the mine owner is working without a plan of a mine or against it; when the work is conducted by a person who is not in possession of a license of capacity; when a mining police direction given in the face of menacing danger is either not at all or hesitatingly carried out.

In Belgium there is a very complete law for the inspection and regulation of mines. Legal provisions are also made for the establishment of relief societies, of which there seem to be a large number established. The head of the administration of mines is the Minister of Industry and Labor, who has a corps of mining engineers under him. It is their duty to watch the execution of the mining law; to examine all gas and steam apparatus; the work of the miners, especially women and children; and the control of explosives. The engineers of the first, second, and third classes attached to the districts, inspect as often as their chief thinks necessary the mines, etc., in their respective districts, watch for the execution of the law and the regulations, etc. When inspecting the mines they have to pay special attention to the safety of the workmen, conservation and constructions, the waters on the surface, the lighting apparatus, the maintenance, descent of workmen, life-saving devices, and the storage and use of explosives.

In France the inspection and regulation of mines is under the Minister of Public Works and the prefects. The Minister has under him a number of mining engineers who have extensive powers of inspection with a view to preventing danger and providing for the pre-

servation of buildings and the safety of individuals. The prefects have also power at the request of the engineers to require mine owners at their own cost to execute the works necessary to protect buildings and to secure the safety of the public, the mines, the workmen, and of ways of communication, mineral waters, and the water supply for towns, villages or public establishments, at the cost of the *concessionaires*. Mine owners are required to keep on their premises, in proportion to the number of workmen and the extent of the workings, such remedies and aid appliances as may be required by the Minister of Public Works, and to conform to the regulations approved by him in that behalf. The mining law provides that in cases of accidents notice must at once be given to the authorities, who shall have power to take all necessary measures either to put an end to the danger or to prevent the consequences; and the owners and managers of neighboring mines are required to furnish all the assistance they can, any expenses of assistance to wounded men or repair of works being borne by the owners of the mine where the accident occurred. The mining engineers or other authorities must report upon the accidents, and in cases of negligence the mine owners and managers may be punished by imprisonment and fine besides being liable in damages. There is nothing approaching compulsory insurance of workmen in France, but by the law of July 11, 1868, any workmen may make provision for the case of death or accident, the insurance fund being administered by the Government officials, and by this law workmen may make similar provision for the case of old age. In addition to the public insurance institutions, there are numerous private associations or mutual-aid societies, the objects of which are usually to make provision for sickness and burial, but occasionally also to provide pensions for old age or incapacity for work. Some of the mining companies make special terms with hospitals for the benefit of their workmen. Others have established hospitals; others have established co-operative shops; others erect houses and establish schools for the benefit of their workmen, while certain companies make free distribution of coal among the workmen.

At the head of the mining administration is the Minister of Public Works, while in each Department the prefect is the head of the service under the authority of the Minister of Public Works. Under the immediate orders of the Minister of Public Works is the Council General of Mines. This is composed of the inspectors-general of the first and second class, presided over by the Minister of Public Works, or in his absence by a vice-president appointed for a year by the

Minister out of the inspectors-general. Below the inspectors-general of the first and second class come the engineers-in-chief, and under these are the ordinary engineers. Engineers-in-chief have to render account to the prefects of mining works, and to receive and execute their orders relative to inspection; to report to the Director-General and the prefects all breaches of the law and regulations as to mines, and to inspect the mines in their Departments in turn under orders of the Director-General. The ordinary engineers must visit at least once a year all the mines being worked in their several departments, and in the case of a breach of the law or any danger or accident, being notified at the working, they must attend at the place and prepare a report for the engineer-in-chief with the view of effecting a remedy. There is a head office of mines in Paris, and the rest of the country is divided into various districts and sub-districts for the purposes of mining administration. No child is employed under the age of 12. The duration of effective work of children of the male sex from 12 to 16 years old in the subterranean galleries of mines, etc., shall not exceed 8 hours in 24, being interrupted by a rest of one hour at least.

The mines of Great Britain are controlled by the Metalliferous Mines Regulation Act and the Coal Mines Regulations Act. England is divided into twelve districts, controlled by Royal Inspectors of Mines. Each inspector is charged with surveying a district. It is the duty of the inspectors especially to visit the mines of their district in order to assure themselves that all prescriptions of the law and particular regulations are duly attended to. In cases of infractions they may advise the mine owners thereof, or provoke a prosecution before the judicial tribunal, which can punish the faulty parties by fines up to £20, or by detentions of three months in serious cases. The visits of the inspectors are made either officially or in consequence of complaints filed, even by anonymous letters. The inspectors have the right to take any measure not provided for in the law or regulations should there be a situation creating a danger. If the mine owner does not agree with the inspector's opinion, an arbitration is created consisting of two arbitrators, one appointed by the inspector and the other by the owner of the mine. If they do not agree a third arbitrator is appointed. The arbitration sentence is a definitive one, without appeal. The value of this sentence for the mine owner is that it is a legislative prescription; every infraction would come under the law. Inspectors are appointed by the Secretary of State. Every mine in which more than 30 persons are employed must be under the control, management, and direction of a manager or under-manager,

who may be the owner or agent or some other person nominated by the owner or agent, and must be registered as the holder of a first-class certificate. Daily personal supervision of every such mine must be exercised by the manager or by the under-manager. The inspectors must be notified in writing within 24 hours of any accident. In case of loss of life or serious personal injury, the place where the accident occurred shall be left as it was immediately after the accident for a period of three days until the visit of the inspector, unless this would tend to increase or continue danger, or would impede the work of the mine.

The Explosives Order contains the list of explosives which have passed the government test, called "permitted explosives." The order applies especially to two classes of seams in coal mines:—seams in which inflammable gas has been found within a previous three months in such quantity as to be indicative of danger, and seams which are not naturally wet throughout. The use of permitted explosives in main haulage roads and main intakes is subject to the further condition that every part of the roof, floor, and sides within a distance of 20 yards from the place where the shot is fired must, unless naturally wet, be thoroughly watered at the time of firing. If explosives not in the permitted list are used, the workmen, with certain exceptions, must be withdrawn from the mine when the shots are fired, but if permitted explosives are used, the workmen need not be withdrawn from the mine provided the roof, floor and sides within 20 yards from the place where the shot is fired be thoroughly watered at the time of firing. The list of permitted explosives may be seen in the copies of the order which are supplied by the Home Office to the mine owners. To each explosive further conditions are attached which must be carefully observed, and the provisions of the order are not in substitution for those in the Coal Mines Regulation Acts or Rules, or of any special rules of the mine, but are in addition to them.

THE REMEDY.

However necessary legislation may be on this subject, the problem in the United States is so complex that those most familiar with mining are convinced that scientific investigation must precede legislation. The coal operators of West Virginia recently adopted a resolution to the effect that:

> "The United States Government should take the necessary steps to determine the causes before any attempt is made to apply legislative

remedies, and when the causes have been ascertained and the remedies suggested, we pledge ourselves to co-operate with the National Congress and State legislatures in the framing and passing of any proper and effective legislation for the protection of life or property which may result advantageously to the National Government, States, labor and capital."

It is the general opinion that extensive scientific investigations should be carried on in the United States to determine the causes of the gas and dust explosions, and also those of other accidents in the mines. It is suggested that an experiment station similar to those in Belgium and Germany be erected at some point within the coal region, at which these experiments may be made. Tentative plans for such a station have been drawn, and the erection of the station simply awaits the action of Congress in the matter of a sufficient appropriation to carry on this work. The station as planned would provide for an explosives gallery, observation house, lamp-testing rooms, and explosives laboratory. The gallery would be made of boiler plate and in the form of a cylinder 100 feet long and 6 feet in diameter. A series of safety valves would be arranged on hinges along the top to allow the escape of gas following an explosion. Port holes along the sides, covered with one-half-inch plate glass, would allow those in the observation house to see whether an explosion had taken place in the gallery during the tests. The cylinder would be filled with fire damp and air, or coal dust and air, and the explosives would be hurled into the gallery by means of a steel mortar fire by electricity from the observation house sixty feet away.

The fire damp and air would be thoroughly mixed by an electric fan. Tests would be made with various explosives, and the maximum quantity of each explosive that can be safely used in mines would be published under the heading "permissible explosives."

Explosives known as "safety explosives" in which the temperature at the point of detonation is low and the flame of short duration, would have a higher "limit charge" than the less safe explosives.

Until these experiments are made and the results known, it is generally conceded that the State legislatures can do but little. West Virginia and Pennsylvania have struggled with the problem for many years and have some excellent statutes on their books tending to guard the lives of the miners. Nevertheless accidents are occurring and recurring with greater frequency. It is hoped that the findings will be of such a nature that when the recommendations are made they will be incorporated into the statutes of the various coal-producing States.

Some of the unsettled problems in connection with the coal-mine explosions in the United States are as follows:—

1. EXPLOSIVES.—The influence of the quantity and quality of each explosive and the methods of using the same, upon the risk of igniting either fire damp or dust, or a mixture of fire damp and dust, and thus causing an explosion in coal mines.

Standardizing explosives used in coal mines in the United States in such manner as to prevent unnecessary variations in the composition of the explosive for which the miner or shot firers would not be prepared.

2. FIRE DAMP.—Variations in the composition of this gas in different coal mines, and the influence of these variations, together with the variation of atmospheric conditions (pressure, etc.) within mines, in lessening or increasing the risk of fire-damp explosion.

Influence of the depth of the mine and distance from the outcrop and of the composition of the coal on the quantity and quality of gas in the coal.

Origin of reported unusual outbursts of gas and how these may be anticipated and counteracted.

3. DUST.—General conditions under which a dust explosion in coal mines may or may not be possible or probable from "windy" or "blown-out" shot, from electric sparks, or other means.

The influence of varying admixtures of fire damp in increasing the risk of or intensifying dust explosions.

The influence of the character and composition of dust from different coals in increasing or decreasing the risk of or force of gas explosions or dust explosions and upon the health of the miners.

The most practicable methods of maintaining the proper degree of humidity of the atmosphere in coal mines.

4. ELECTRICITY.—The conditions under which electricity may be safely used in coal mines for haulage and other purposes—whether an electric spark may cause a coal-dust explosion, or if gas is also necessary, what percentage, etc.

5. ATMOSPHERIC CONDITIONS.—(barometric pressure, temperature, etc); their influence, if any, in inducing mine explosions or conditions favorable or unfavorable to the same.

FIRE PREVENTION IN HIGH BUILDINGS. THE NEED OF AUXILIARY EQUIPMENT.

By J. K. Freitag, C. E.

THE burning of the twelve-story fireproof Parker Building at Fourth Avenue and 19th Street, New York City, on the night of January 10, 1908, is of peculiar interest to architects, engineers, and fire protectionists, in that the destruction by fire of individual fire-resisting buildings of great height has been comparatively rare. The behavior of such buildings under fire test is ever an interesting and vital speculation, and each trial of modern fire-resisting methods in high buildings, while deplorable from the standpoint of loss of life and property, is nevertheless of great value in helping to determine the worth or worthlessness of so-called fireproof construction. The present instance is not without its valuable lessons.

Widespread conflagrations such as those experienced by Paterson, N. J., Baltimore, and San Francisco, have pointed many morals which we are only too slow to follow, but the ruin in such calamities is so widespread, and the lessons presented are so multitudinous, that the full force of the application to individual buildings is apt to be overlooked for the more general, but quite as important, moral regarding the necessity of *uniform fire-resisting construction* within the congested areas of large cities. Again, past conflagrations have shown the almost utter uselessness of attempting to cope with fire when once it has reached the proportions of what is usually termed a conflagration. No structural materials of which we have present knowledge are equal to the task of resisting successfully such severe test conditions, at least to a point which would justify any reliance upon their use; while the points of attack in conflagration are so numerous and all conditions are so severe that the standards by which it is reasonable to judge fire-resisting construction are overthrown.

Fires in individual buildings with which the fire department is called upon to cope, prove, therefore, more instructive, and of such examples of fires in fireproof buildings exceeding ten stories in height, where the structure has been subjected to great or total loss, the Parker building furnishes but the fourth instance of prominence. It is only the second noteworthy example of practically complete loss to a high fire-resisting building in which the fire originated on the premises.

This fire serves to illustrate vividly certain prevalent weaknesses in fire-resisting design and construction; the value of such construction, notwithstanding faults of omission and commission; and, especially, the limitations of fire-department efficiency where very high buildings are concerned, and the imperative necessity of auxiliary equipment which shall aid the department in both the discovery and the fighting of fire.

The complete destruction of this building and contents, a loss now estimated at approximately two millions of dollars, may be directly attributed to two serious defects.

The first was a very prevalent fault in design and planning, *viz*, the open stair well and elevator shaft. Much has been said and written regarding the hazard of vertical openings in mercantile and other buildings, but no fire has ever more clearly demonstrated the widespread ruin which may result from failing to consider or failing to provide against the communication of fire from floor to floor by these means. I happened to be at the site of the fire in question when the alarm was turned in, and, before a single engine had arrived, and when flames had broken through only a few of the fifth-story windows on 19th Street, the fire could be plainly seen through the closed iron shutters on the east wall, working up rapidly from story to story through the open stairwell at that location, until, as the upper floor was reached, the flames spread out umbrella-like, enveloping the upper story, and then worked downwards again through other shafts.

Here was a "fireproof" building, provided with steel frame, adequate masonry walls, fire-resisting floor arches and column protection, and withal, open stairways and elevator shafts. Is it not a pertinent question to ask why this or any other similar building should be provided with fire-resisting floors and partitions, whose offices are obviously to *prevent* the communication of fire from room to room or from floor to floor, if the entire scheme or plan of fire-resistance is to be rendered null and void by the introduction of vertical flues which, in time of fire, present the surest and most effective means of communicating flame from floor to floor, and from basement to attic?

It is, perhaps, difficult to reconcile the theoretical advantages of isolated stair and elevator well-holes with the practical disadvantages which sometimes result from such isolation; for when the requirements of adequate fire protection seriously interfere with the conventional architectural treatment of the interior of the building, the introduction of any methods of fulfilling such requirements is most difficult to obtain.

In the latest and best examples of fire-resisting construction the problem of an architectural and yet efficient elevator enclosure has been solved through the use of wire glass, which, while still allowing the radiation of great heat, nevertheless confines the flames to the flue or shaft so protected, thus forming a temporary barrier to the horizontal spread of fire at each floor, efficient at least until the fire department work is well organized; and lateral spread is prevented. But it is still indisputably true that stairways should also be isolated, preferably to serve as safe fire-escapes within masonry partitions, with fire-resisting doors at each floor; or as has been the case in a few commendable buildings, they may be placed within a shaft adjacent to the elevator well, with a stairway enclosure opening onto each floor of the same construction and architectural treatment as the elevator front. Doors in such partitions may have counterweights and fusible links, thus closing automatically at a certain heat.

The second serious defect in the Parker building instance, was the absence of thermostats or automatic fire-alarm system. This fire had evidently gained great headway before it was discovered by the watchman, and, although the building was equipped with special building signal fire-alarm box, it is asserted that the watchman turned in the first alarm from a street box. The building was also provided with standpipe and basement open sprinklers, but these auxiliary appliances are required by law, and the provision of such protection is too often perfunctory, to cover some requirement in the local building laws or regulation of the fire department, rather than to provide and *suitably maintain* a system of fire-protection auxiliaries which may very likely prove of the utmost importance. For fire protection, viewed in a comprehensive light, must include not only those *passive* qualities of fire-resistance which result from the employment of proper materials in suitable design and construction, but also those *active* means of fire-detection and fire-fighting appliances which do so much to supplement and make effective the purely passive elements in the scheme of fire protection. *Fire protection must be aggressive as well as purely resistant.* Fire protection must consider the contents of a building as well as the structure itself. An incombustible building does not eliminate damage or destruction to the contents. Many a heavy loss has occurred to stock or contents through a quick sweep of flame which has worked comparatively little damage to the building itself. Such a result, while possibly affording a most gratifying object lesson as to the structural efficiency of the building, might be most satisfactory to the owner of the structure, and yet spell ruin to lessees

of the premises. Hence adequate fire protection must consider the contents as well as the surrounding building.

Furthermore, fire protection worthy the name means not only the salvage of the main structural elements of the building after trial by fire; but considerations of uninterrupted business, and insurance interests, both require that the expense and time consumed in making repairs and reconstruction shall be reduced to a minimum. Without auxiliary equipment it is problematical how far incombustible construction *per se* will accomplish such a result. The neglect of those automatic or supplementary safeguards which even the best construction needs, may readily permit a fire to attain such area and intensity as to be beyond the power of the fire department.

The fire in the Parker building illustrates these truths most forcibly. Had the building been equipped with automatic fire alarms, notification of the fire would have been instantly and automatically sent to the central station, which, in turn, would have transmitted the alarm to the fire department. Any authoritative statement as to the result is out of the question, but it may safely be said that the probability is strong that the fire would never have attained sufficient magnitude before the arrival of the department to have completely gutted the building. Had automatic sprinklers with central-station notification system been installed, the result would probably have been even more satisfactory, for, in addition to the alarm which would have been instantly sounded on the premises (and to the supervising central station as well, if installed upon latest and most approved principles), the discharge of water from the sprinkler heads would have immediately begun its work of extinguishing, or at least checking, the rapid spread of the fire. In such a building as the present example, devoted to various mercantile interests, automatic alarms or sprinklers, or both, would not only have been advisable adjuncts in any thorough and comprehensive scheme of fire protection, but should have been considered indispensable, especially in view of the limitations of fire-department work, which will now be considered.

Since the advent of the many-storied office building in most American cities, it has been plain to those actively employed in the business of fighting fire, as well as to those who have thoughtfully followed the course of high-building construction, that the days of the ladder and hose in the hands of courageous and intrepid firemen were gradually passing from their hitherto unquestioned fire-fighting sufficiency, to partial if not complete impotence where the high building was concerned. This fact had been realized partially in the early nineties,

while office buildings were rapidly developing from the modest ten stories of the Home Insurance Company's building in Chicago—the pioneer of skeleton construction methods—to the twenty-storied Masonic Temple in the same city, and the Manhattan Life building in New York City; but it was not until 1898, when the Home Life building in New York City was almost completely destroyed by fire above the eighth story (an "exposure" fire), that it became clear to those most intimately engaged in the fire problem—*viz*, the municipal fire department—that new fire-fighting facilities would have to be relied upon more and more in the successful coping with fire above the ordinary range of the department's efficient efforts.

This burning of the Home Life building—a sixteen-story office building which was considered thoroughly fire-resisting according to the standards of its day—demonstrated the fact that, notwithstanding the most modern apparatus of the New York City Fire Department, it was impossible to combat the flames successfully above the eighth story, at least after the fire had assumed serious proportions. In other words, modern *portable* fire apparatus is not and cannot be made efficient for fire-fighting purposes above the limit of about 125 feet above the street level. This is practically equivalent to saying that fire once established above the tenth floor of modern high buildings must be left to burn itself out, as far as portable department apparatus is concerned.

The difficulty experienced in fighting fire in high buildings may be said to increase about as the square of the height. Buildings 300 feet high are no longer marked curiosities in New York City, where no building regulations limit the height of structures (except tenements), and a census of the high buildings recently made by the New York City Building Department shows a total of 538 structures which are 10 stories or more in height;—*viz*, one building (uncompleted) of 48 stories, one of 41, two of 26, three of 25, two of 23, four of 22, nine of 20, two of 19, nine of 18, two of 17, nineteen of 16, nineteen of 15, eighteen of 14, thirteen of 13, one hundred and sixty-nine of 12, one hundred and one of 11, and one hundred and sixty-four of 10 stories. In other words, there are these 538 buildings in New York City which, as far as efficient fire protection is concerned, are above the effective fire-fighting range of the fire department, when working without auxiliary aids; and when it is remembered that the 48-storied tower of the Metropolitan Life building—658 feet high—and the 41-storied tower of the Singer building—611 feet high—are both to contain offices to a height greater than the Washington Monument, the

necessity for every possible form of auxiliary equipment looking to the discovery and extinguishment of fire, as well as the need of adequate provisions against smoke and panic, are sufficiently apparent.

Such added facilities for fire protection could not be looked for in any possible improvement of the personnel of the departments, as that had already reached a high degree of excellence; nor in added pumping capacity in fire engines sufficient to meet the new demands of excessive height, although the new high-pressure service soon to be installed in New York will prove of immense value in high-building fires; nor in heavier or stronger hose to withstand the bursting pressures induced by great heights, even though no criticism might be made regarding the bursting of poor hose, as was the case at the Parker building fire; not, in fact, through new portable apparatus of any kind which would solve the problem. The only possible remedies lie, therefore, in the *improved design and construction* of high buildings, and in the employment of *auxiliary fire-detecting and fire-fighting appliances* which should especially be incorporated in the inherent design of each and every building exceeding the height limit of fire-department efficiency.

The matter of design includes such considerations of planning as limiting areas, enclosed vertical openings, exposure hazards, and the isolation of dangerous risks of any and all kinds.

Construction concerns the carrying out of such design through the employment of suitable fire-resisting materials, and with a minimum use of combustible trim, etc. But, beyond all of these elements of fire-resisting design, there are still required those auxiliary aids for detecting and extinguishing incipient fire, such as auxiliary fire alarms and automatic sprinklers, and also those auxiliary appliances which go so far to aid the fire department work under severe conditions. Such appliances include the open or basement sprinklers for flooding underground areas, standpipes and hose connections and reels at all floors, and monitor roof nozzles. It is only through the installation and use of such auxiliary equipment that buildings over ten stories high may be considered in any sense fire-resistive.

It is true that the Parker building was destroyed in spite of a standpipe equipment which was used by the firemen until they were either overwhelmed by falling floors or surrounded by flames which had worked around and below them. It is also true that there was much criticism regarding poor water pressure and bursting hose. But had the building been equipped with automatic fire alarms or sprinklers, and had all vertical openings been thoroughly protected, the loss might easily have been confined to inconsiderable proportions.

MODERN SYSTEMS FOR THE VENTILATION AND TEMPERING OF BUILDINGS.

By Percival Robert Moses.

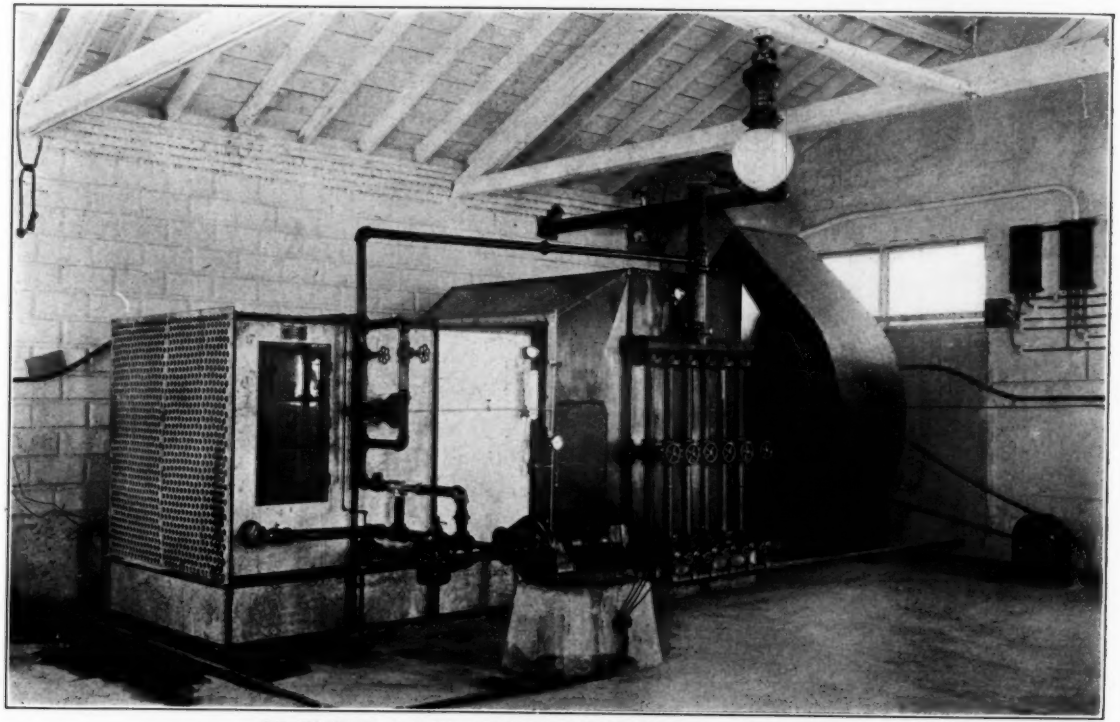
Mr. Moses treats, with the authority of a specialist, one of the modern sub-divisions of mechanical engineering in which American practice is far in the lead of any other. He presents a general review of the accepted principles and available type of apparatus.—THE EDITORS.

WITH the development of greater scientific knowledge of the requirements of the human system, a demand has arisen for more perfect regulation and moderation of the temperature and quality of the air in our dwellings and workshops. This demand has led to the development of systems of heating and cooling far more elaborate than the old systems, and more complete in the results accomplished. Coincident with the development of improved heating and ventilating arrangements, has come the development of illuminants which do not use up the oxygen and which do not produce excessive heat. Necessarily the installation of these complete equipments is confined to large buildings used for public or semi-public purposes, or to houses owned by wealthy people who can afford to pay for conveniences and comforts.

A modern heating, ventilating and cooling equipment, or as it may be termed, a "Tempering Equipment," should give the following results: an abundant supply of fresh tempered air, free from dust or other impurities, and containing a regulated supply of moisture.

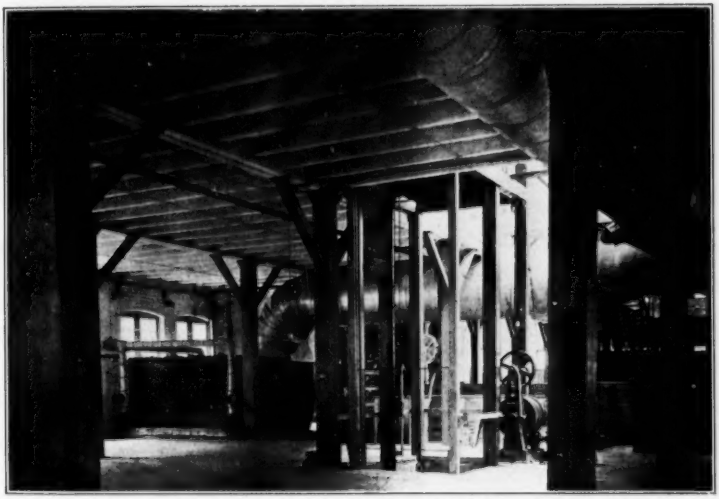
Apparatus for obtaining these results includes a more or less extensive arrangement of screens to take out the dust from incoming air, or washing apparatus to wash out the particles, fans or blowers designed to create a difference in pressure which will cause the air from out doors to flow through the screens into the fan or blower and be discharged at suitable velocities to the rooms requiring tempered air, and similar fans to exhaust the vitiated air and discharge it out doors; and heating or cooling devices to bring the air to a temperature and a degree of humidity suited to the requirements of comfort and hygiene. The tempering of the air proper may be carried on either before or after entering the fan.

The two operations of heating and cooling are performed in similar ways, with the same or similar appliances. For heating the air,



AIR-WASHING AND HUMIDIFYING INSTALLATION IN A SILK MILL.
Plant of the Huguet Silk Co. Installed by the Buffalo Forge Co.

coils containing steam are placed on either the intake or discharge; while for cooling, coils containing cold brine or expanding ammonia gas are used. The admission of steam or brine or ammonia to these coils is controlled automatically by sensitive thermostatic mechanisms located in the rooms. This automatic control is not only a convenience but an economy, as it tends to prevent waste. When the air is heated its percentage of saturation is decreased, and its ability to take on moisture increased. This dryness is objectionable in cold weather, and to overcome it the humidifier is employed, consisting of a coil of pipe containing steam immersed in a bath of water. Steam is automatically turned on, evaporating the water, or shut-off from this coil, as the percentage of humidity in air is to be increased or decreased.



HEATING INSTALLATION, ANGUS SHOPS, CANADIAN PACIFIC RAILWAY.
The B. F. Sturtevant Co.

On the other hand, when the air is cooled, the percentage of saturation is increased, and the tendency to deposit moisture on cold surfaces is increased. This may result in injury to woods or fabrics, and where the amount of cooling is considerable, means for drying the air must be provided. The method of obtaining comparatively dry air is to cool the air far below the temperature at which it is to be delivered to the rooms, causing it to deposit some of its moisture on the pipes by which it is cooled, and then to allow it to heat up again by contact with other air or by passing over steam coils, thus reducing the percentage of saturation. This operation is also

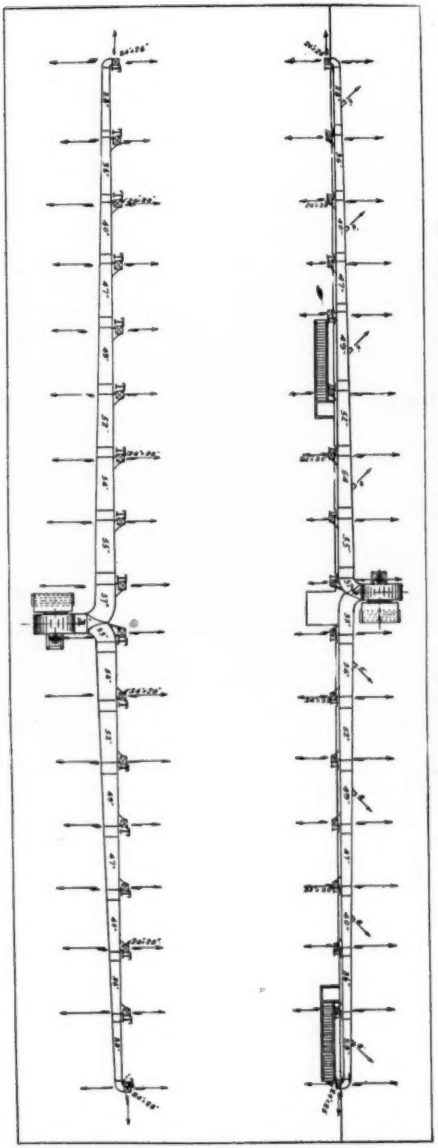


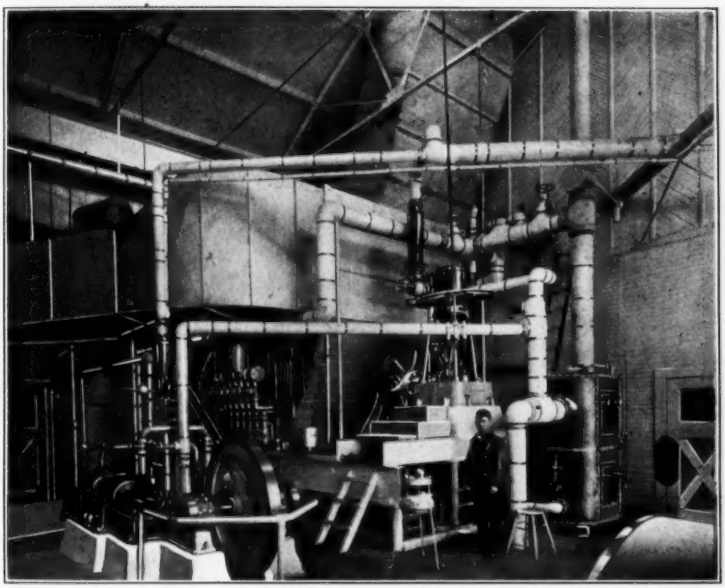
DIAGRAM OF HOT-BLAST HEATING SYSTEM, MACHINE SHOP OF ILLINOIS STEEL CO.
The Green Fuel Economizer Co.

automatically controlled, and the heating is accomplished by a mixing damper or by opening or closing the supply of steam to the coil.

Recently methods have been developed for cooling and heating air and regulating its humidity, by driving it through a finely divided shower of water, passing over heating or cooling coils. The water drops to a pan and is re-circulated. It would seem that such a process would result in the delivery of air completely saturated with moisture and, therefore, liable to deposit a part of its charge as soon as it was cooled. In practice, however, the plan works well. When the outside air is cold its percentage of humidity is low, and when it is heated by merely passing over steam coils its moisture per cubic foot—i. e., its humidity—is still further reduced.

The objectionable

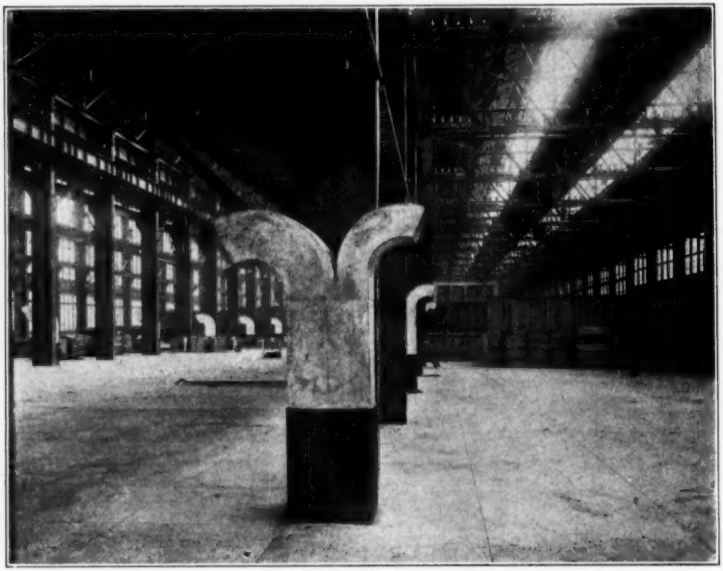
features of very dry air are well-known. The membranes of the throat and nose, and the skin itself, are robbed of their moisture by the thirsty air, and a parched, dried-up feeling results, while the membranes become subject of inflammation familiar as colds and sore throats. By regulating the temperature of the water, and the rapidity of its flow, the humidity of the air delivered can be regulated and the excessive dryness prevented. On the other



HEATING AND VENTILATING INSTALLATION, LOYER PLANT OF THE CHICAGO PNEUMATIC TOOL CO.
The American Blower Co.

hand, when the air is cooled the object is usually to reduce the humidity, which is generally excessive, and this result is also accomplished by the direct contact of the air with the falling particles of very cold water or brine. These cold particles apparently reduce the temperature of the portions of the air with which they come in contact below the dew point, if the air is at all near saturation, and instead of water being evaporated from the shower, water is actually squeezed out of the air, which is thus dried and cooled at the same time. This result is clearly shown in the plant of the New York Hippodrome, where instead of having to replenish the supply of circulated cooling water, it is necessary to draw off water condensed from the air.

There are important mechanical advantages inherent in such systems of heating and cooling due to the small amount of pipe radiating surface required on account of the greater ratio of heat transmission between heating or cooling surface and water as compared with that between the same surfaces and air. This results in smaller installations, which will necessarily be less costly, and in a much simpler equipment, as filtering screens are eliminated and the number of coils, with valves and traps, greatly reduced.



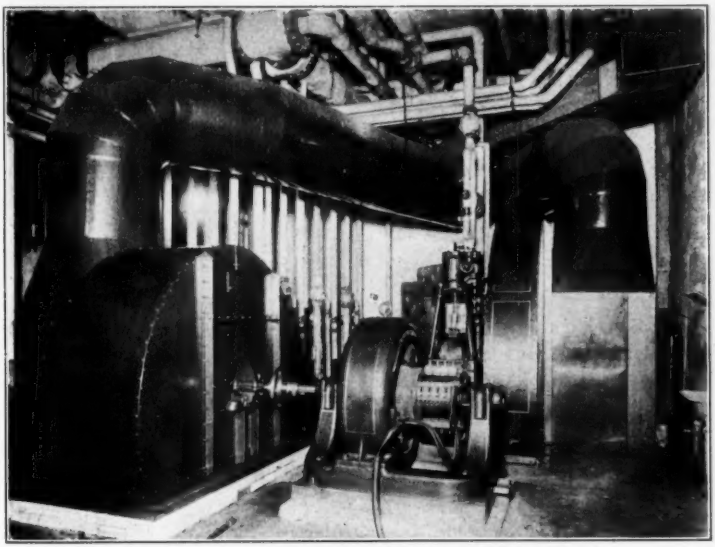
OUTLETS OF HEATING DUCTS, LOUISVILLE & NASHVILLE R. R. MACHINE SHOP.
The B. F. Sturtevant Co.

After being thus tempered, the air must be discharged into the rooms in such direction and at such velocity as will not cause appreciable draft on the people in the room and, at the same time, will insure a perfect diffusion and distribution throughout the entire space. As cold air is heavier than warm air, the natural impulse would be to discharge the heated air at the bottom, allowing it to rise, and the cold air at the top, allowing it to fall. Such an arrangement is used for large auditoriums such as theatres where the space is very high, but a contrary arrangement has proved necessary for smaller rooms, or rooms having a great area compared to their height, in order to secure distribution of the fresh supply throughout the space. The warm air enters such rooms at a point about two-

thirds of the height from the floor, and as it meets the cooler air of the room it becomes cooled and falls. The cold air entering the room near the floor, sufficiently high above the floor to avoid dust, becomes heated by contact with the air of the room and rises. Where it is possible to do so, the air is usually discharged from the inside wall toward an outside wall or exposed surface, and the vitiated air removed from the wall containing the inlet. For warm air this discharge is taken out near the bottom; for cold air it should be taken out near the top.

The same ducts may be used for cool and heated air, but for a perfect system of distribution there should be two outlets in each of the supply and exhaust ducts, the top supply and the bottom exhaust outlets being used for heating, and the others for cooling.

The vitiated air of the rooms is perfectly removed mechanically by a fan, similar to the fan used for the supply, through ducts and outlets as stated.

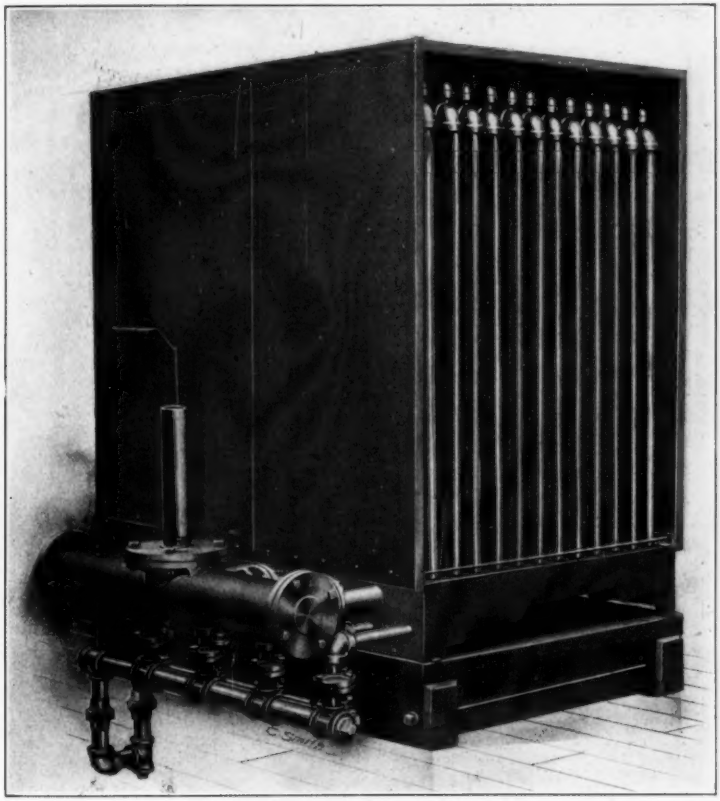


HEATING INSTALLATION, FIRST NATIONAL BANK, CHICAGO.
The B. F. Sturtevant Co.

This is briefly the method of accomplishing the results, and no attempt will be made to consider all the methods and modifications used in practice, but there are a number of points which may be worth noting. Commencing with the entrance of the air, it is important that the air obtained shall be as clean as possible; hence a

HEATING AND VENTILATING INSTALLATION, MOLINE SHOPS, C., R. I. & P. R. R.
The B. F. Sturtevant Co.

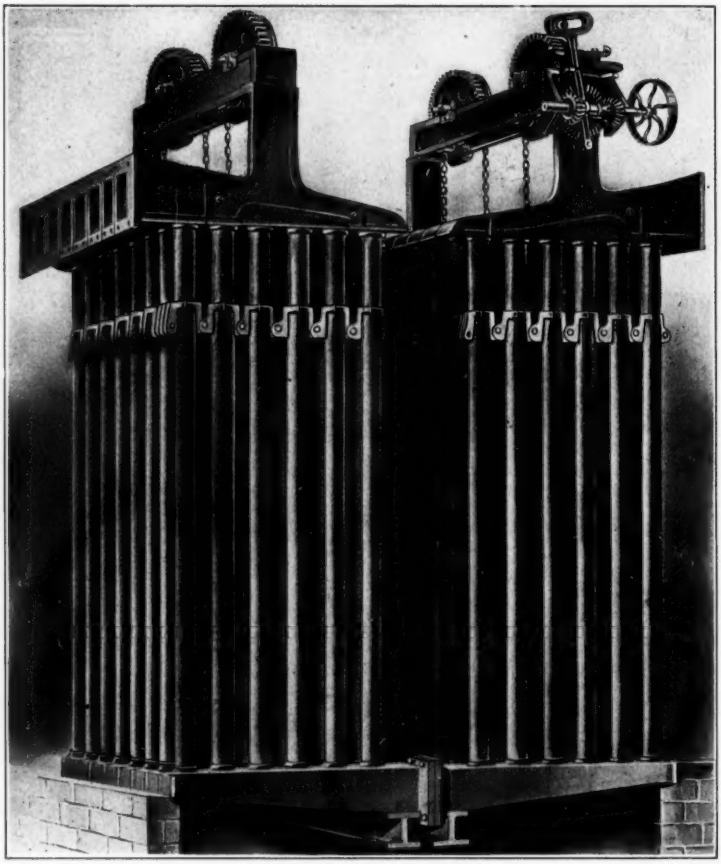
supply from the level of the street or from any location liable to contain impure air should be avoided. On the other hand, it is not necessary to go up to the top of the building to obtain pure air, as the air obtained from a court or from a point sufficiently high above the ground to avoid the direct entrance of impurities meets the needs of the case. The entering velocity of the air should be low, hence the area of the intake must be large. The usual velocity for such incoming air is ten feet a second; where it is higher than this, the tendency is to draw dust and dirt in with it. It may be lower without any bad effects, provided the space is available.



HEATER, SHOWING ARRANGEMENT OF COILS.
The American Blower Co.

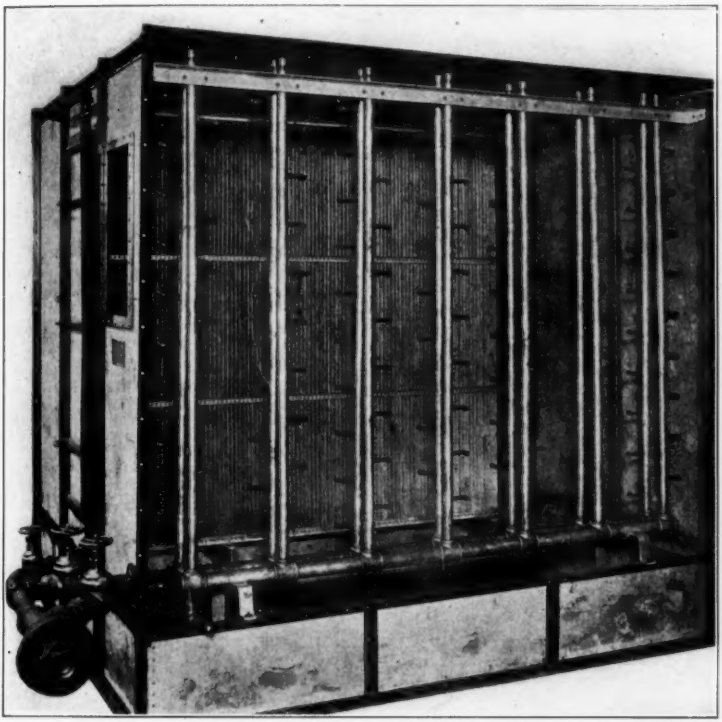
In designing screening apparatus it is of the utmost importance that the screens shall be readily cleaned, and the cleaning done

away from the intake of the fan. This means removable screens, and the placing of the screens in a position where they can be very readily taken down; and further the use of a suction blower or similar arrangement which will draw the dirt from the screen and discharge it where it will do no harm. More than half the screens in use, it is safe to say, are not properly cleaned or looked after, and when thus neglected they become a menace to health and a hindrance to the proper and efficient operation of the fan. The screens are almost always arranged in zig-zags so as to reduce the space re-



THE GREEN AIR HEATER.

Utilizes the waste heat of flue gases from boiler or other furnaces, applying it to the heating of air for ventilating or drying purposes. The air passes through the tubes, and the flue gases circulate around them. The Green Fuel Economizer Co.



AN AIR WASHER, COMPLETE, SHOWING THE SPRAY SYSTEM.
The Buffalo Forge Co.

quired and, at the same time, give the necessary surface. The amount of surface required varies with the location of the air intake, but an average figure is one square foot of surface for every thirty-five cubic feet of air supplied per minute. These screens are made of cheese cloth framed in galvanized iron mesh. Where vacuum cleaning systems are in use a suction outlet with flexible hose and collector is arranged for cleaning the screens.

The coils for heating or cooling the air, as has been stated, are located alternatively on the intake or discharge. The most efficient and economical location for the cooling coils is on the intake, and for the heating coils is on the discharge; such an arrangement gives the smallest size of fan for a given quantity of air moved per minute, as the air is at its maximum density in passing through the fan. There are a number of reasons, however, militating against this arrangement, and the most usual plan is to place the coils on the intake;

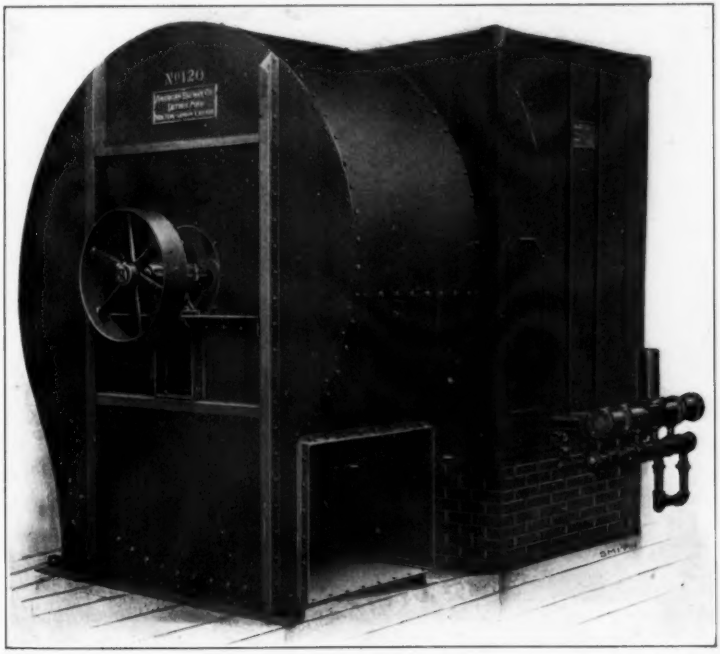
THE GREEN HEATER.
Straight tubes, expanded into the headers. Easily cleaned, plugged, or replaced. Positive circulation. Used with live or exhaust steam or with water. Green Fuel Economizer Co.

because where space is limited, there will be a more perfect distribution of air over the coils where the flow is caused by atmospheric pressure discharging into the neck or reduced-pressure end of the fan intake, than where the flow is caused by a positive directive force such as a centrifugal fan exerts. Where the space is not limited, it is better to put the heating coils on the discharge, as the capacity of the fan will be from 20 to 25 per cent greater than with the other arrangement, but the coils must be located sufficiently far from the fan to allow the velocity of flow to decrease gradually before entering the coils, and to increase after leaving the coils.

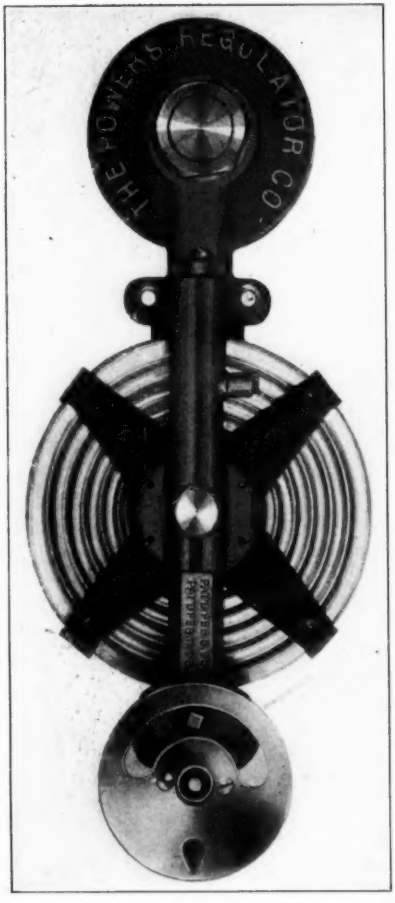
There is no reason why the same coils that are used for heating should not be used for cooling, if brine made up of calcium chloride is circulated through them. This brine is cooled by one of the commercial types of refrigerating machine in the ordinary manner, by the expansion of ammonia in cooling pipes surrounded by the brine which it is desired to cool. It would seem cheaper and simpler to use the ammonia directly in the cooling coils, and this was the first method adopted; but it was not found entirely practicable, as the expansion of the ammonia from liquid into a gas was so rapid because of the rapid passage of the incoming air over the coils that the moisture in the air froze on the pipes, making it difficult to force the air through. The approved practice, with coil systems therefore, is to expand the ammonia in coils surrounded by brine and to circulate the brine through the cooling coils of the ventilating system. As the brine is necessarily of a higher temperature than the ammonia, this involves more surface for brine circulation than for ammonia expansion, but it is found that the amount of surface required for heating is far in excess of that required for cooling, even with brine, so that where the some coils are used for both purposes there is but

little extra expense for the brine system. There is a further advantage in using the brine circulation; that is, the reduction in danger of ammonia in cooling pipes surrounded by the brine which it is no possibility of this with the brine system, but with the ammonia system, if a leak of any magnitude should develop in the coils, a considerable quantity of ammonia might be carried into the rooms before the feed could be shut off.

The method of controlling automatically the supply of steam or brine to the coils, as before stated, is a combination of thermostats and valves controlled by these thermostats. The thermostatic control accomplishes usually two results: First, to prevent the delivery of untempered air to the rooms under any circumstances; and second, to maintain the temperature of the rooms at a fixed amount. To accomplish the first result, it is necessary to put an operating thermostat in the duct leading to the room or space to be applied with tempered air. This thermostat is arranged to open the valve in the supply whenever the temperature of the air in the duct falls or rises



A VENTILATING AND HEATING OUTFIT.
The American Blower Co.



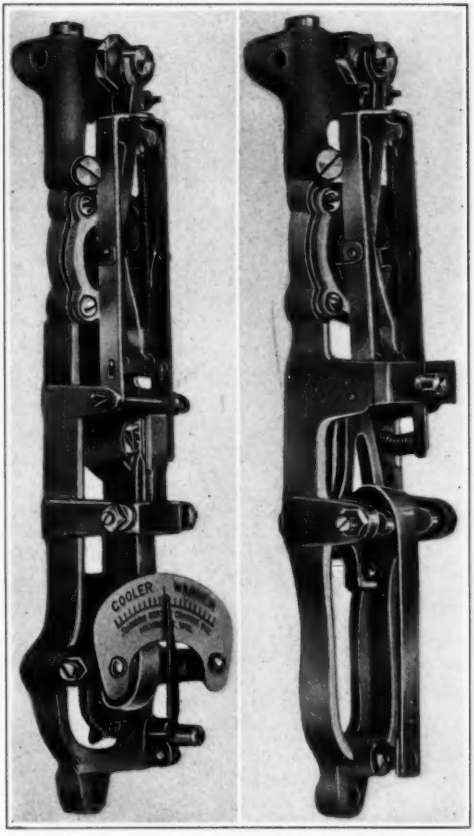
MECHANISM OF THE POWERS THERMOSTAT.

A liquid of low boiling point within the expansible disk exerts in it a pressure varying directly with ordinary temperatures. The resultant movements of the disk, through an elastic diaphragm behind, connected with an air valve, control the flow of compressed air to an air motor operating against a coil-spring resistance, and hence moving the steam valve or mixing dampers to a position corresponding always with the temperature of the thermostat disk. The upper circular portion is the "accelerating valve" for converting gradual action into positive action.

above a stated point. To accomplish the second result, the operating thermostat is hung in the room at some point free from drafts or air currents and at about a man's height from the floor. The thermostat in the duct usually controls a few sections of the heating coil, the remaining sections being thrown on by the room thermostats. There are several such thermostatic systems on the market operating under patent rights, such as the Johnson system and the Powers system, the difference being mainly in the construction of the thermostats.

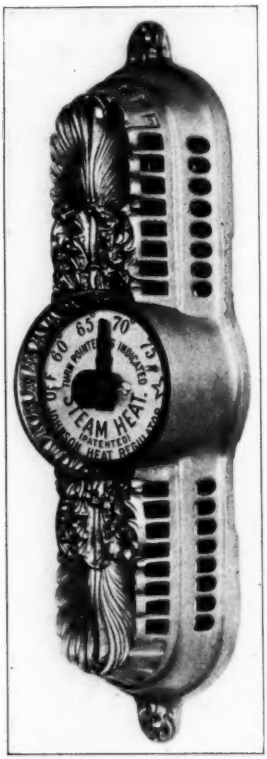
Where the space to be supplied with tempered air is large and undivided, the thermostat in the room and the thermostat in the duct suffice with a single coil or set of coils. Where the spaces are subdivided and separated, it is necessary to have a thermostat in each space separately controlling its air supply. There are two ways of regulating such separated supply: The first is to have a reheating coil at the base of the duct leading to the space in question, this reheating coil being controlled by the thermostat in the room. The other arrangement is to have a double duct system, one duct containing cold air, and the other

tempered air. These ducts are joined together at the base of the flue leading to the space to be supplied, and the relative amounts of cool and warm air admitted are adjusted by a damper, which damper is controlled by the thermostat in the room. With either of these methods the required amount of air for ventilation can be supplied and the temperature maintained at about a given point; while the first method is the simpler, the regulation of temperature is not as quick on account of the heat retained in the reheating coil, even after the steam is shut off. In order to avoid possible misunderstanding it may be well to state that the thermostats do not directly operate the valves or dampers. Their function is similar to that of a relay in telegraphy—that is, to open or close a circuit, allowing compressed air, electricity, or other energy transmitter to flow and operate the valves through unbalanced pressure on the underside of the diaphragm or similar arrangement. The regulation of humidity is accomplished in a similar manner, wet and dry bulb measuring apparatus being used to open and close the circuits, instead of the ordinary measuring devices.



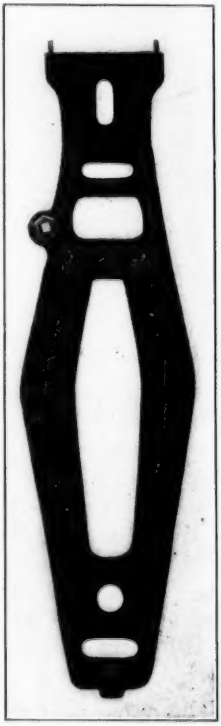
MECHANISM OF THE JOHNSON THERMOSTAT.
The metal strip at the bottom is the actuating member, operating by the different expansion of two metals under heat changes. Its movement opens and closes the small air valve at the top, which in turn governs the air-motors regulating the hot water or steam valves or the hot and cold air dampers. The Johnson Service Co.

The ducts conveying the air from the fans to the rooms are



JOHNSON THERMOSTAT.

usually of galvanized iron varying in thickness from No. 20 gauge for large ducts to No. 24 and even No. 26 for vertical flues. The sizes are fixed by allowable velocity which in horizontal ducts is from 15 to 20 feet per second and from 12 to 15 feet per second in vertical flues. Where the air enters a room its velocity should not exceed 6 feet a second, except in extreme cases where the air has to be discharged a long distance and a question of drafts is not important. The design of the ducts has a great bearing on the success or failure of the system. Air is readily and rapidly moved by very small differences in pressure, and such small differences in pressure are liable to exist from all sorts of causes, such as open dampers and registers, etc. It is important, therefore, that a system of ducts should be designed to insure a proper division of air between the different supply ducts to rooms without having to maintain a greater pressure than would be necessary to insure the required velocity with a natural division of the flow of air. If the air has to turn sharp corners, and thread its way through numerous bends on one duct, it becomes necessary to throttle down the supply to all the other ducts and increase the pressure in the main supply in order to get the required amount through the crooked duct. Such an adjustment can not give satisfactory results, as the increased pressure causes increased veloc-



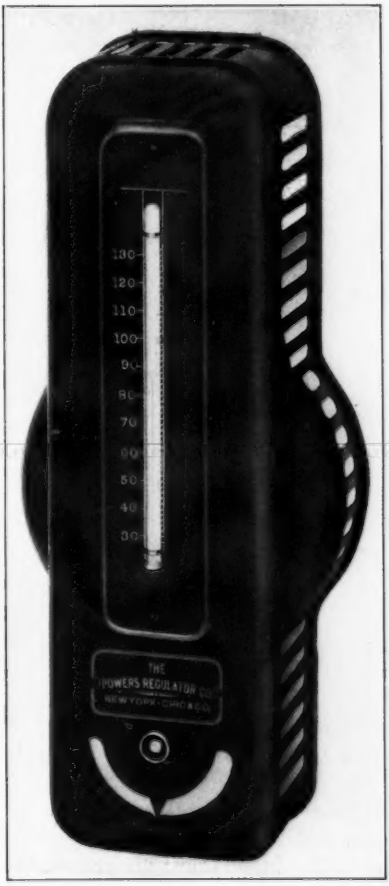
WALL PLATE OF THE POWERS THERMOSTAT.

Showing the ports for the compressed air pipes.

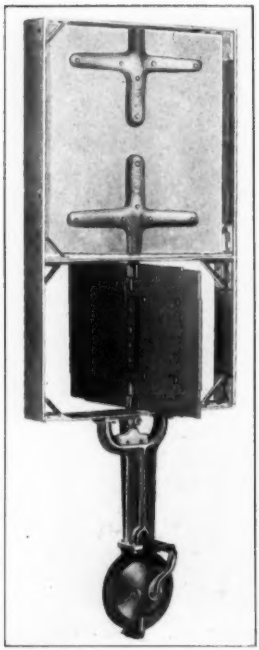
ity, and although the quantity supplied through a certain branch may be reduced by shifting its deflector, there will probably be a whistling sound and the most direct branches will receive the most air. A properly designed system should provide for easy and gradual change in direction of the flow of the air with as few bends as possible, and the main ducts should be gradually reduced, as branches are taken off, so that the natural tendency will be for the air to divide and go partly through the small branch and partly through the large duct. Every such system of ducts should have movable deflectors at each branch, as no system can be planned before hand to take care of variations in pressure in rooms on different sides of the building.

It is usual to cover the main ducts with some insulating material, such as air-cell covering, in order to prevent the unpleasant radiation of heat. As the temperature of the air in the ducts is frequently 120 degrees, unless they were covered, radiation would have a considerable effect on the surrounding rooms and the air would be cold before delivery. For the same reason, it is usual to cover the housings of the fans, where the heater is on the intake, and the housing of the coils. This housing is also advisable to prevent loss through radiation and leaks through sudden changes of temperature of the heating surface as steam is turned on and off automatically.

A fruitful source of trouble in the design of heating and ventilating systems



POWERS THERMOSTAT, COMPLETE.
The Powers Regulator Co.



DOUBLE SQUARE FLUE DAMPER.

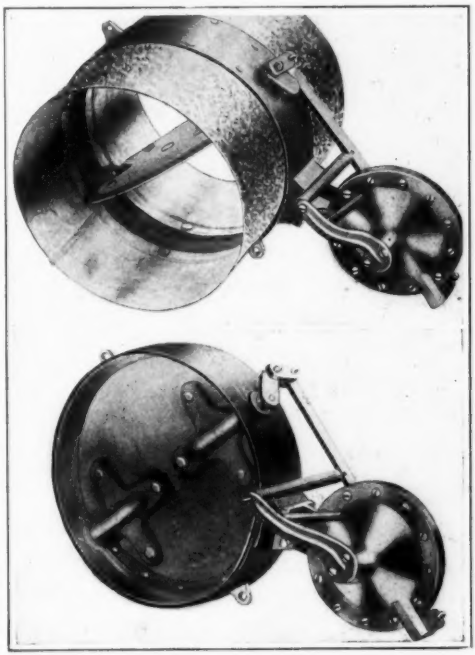
The hot and cold-air flues are superposed, and the dampers are at right-angles and on the same spindle. As one opens, the other closes. The air motor controlled by the thermostat is rigidly attached below. The Johnson Service Co.

is in the exhaust system. Some positive method of exhausting the air is necessary. It is not safe to rely upon natural ventilation to get rid of the heated air or cool air, as variations in the direction of the wind, opening and closing of windows, opening and closing of doors, all affect the operation, and may make a system a complete failure unless there is some more positive means of exhausting the air from the room than can be obtained by natural circulation. A great many of the school houses of New York City were designed with merely a forcing apparatus for discharging the air into the rooms, but no means were provided for drawing the air out. Large flues were provided to allow the air to come out naturally, but it was found in many instances that instead of the air going out cold air came in, and it was necessary to board up the openings in order to prevent the inrush of cold air.

Unless the air to be exhausted is confined to one large space, it is not possible to put a fan at each space from which the air is to be taken. The question then becomes one as to whether it is better to put the fan at the end of the series of ducts, or to put it somewhere between the end of the series of ducts and the discharge to the atmosphere. It is my experience that the latter is the best. If the fan is located at the end of the series of ducts just before the air is discharged to the atmosphere, there are liable to be all sorts of inleakages, and all the friction of the ducts is pulling on the air, preventing it from being freely fed to the fan. It is my practice to locate the fan used to exhaust the air at some point between the long discharge flue and the various flues leading in from the rooms. In this way the work on the fan is divided equally between the discharge and the suction side.

It is of the utmost importance in the design of the exhaust system that the area of the ducts be maintained throughout their length. Any contraction in area, or any sudden sharp bends will materially

affect the operation of the system. The amount of air flowing from an outlet to the fan, depends solely upon the frictional resistance of the ducts and inlets. The vacuum or minus pressure exerted by the fan suction is a constant for a given speed, so that it does not matter how many ducts there may be leading to a fan suction, if the total quantity of air discharged by the fan is not greater than its rated capacity; the shutting off of other ducts will not benefit the exhaust from any one duct through which the proper supply of air may not be coming, due to improper design and excessive friction. In this way the exhaust system differs materially from the supply system. In the supply system if one of the ducts is getting more than its share, it may be cut down by the use of deflectors, but in the exhaust system, the use of deflectors shutting off one, two or three ducts would not increase materially, the amounts drawn through the other ducts. In some cases the smokestack is enclosed by a ventilating flue, the heat of the stack being used to heat the air in the surrounding flue, causing this to rise and draw in the air from below. Such a system is all right where the space to be ventilated is at or near the base of the stack, but it is of no use at all where the space to be ventilated is near the top of the stack. In one instance, rooms on the fourth and fifth floors of a seven-story building were to be ventilated in this manner, but instead of the air from the rooms going out around the stack, the air from the space around the stack poured into the



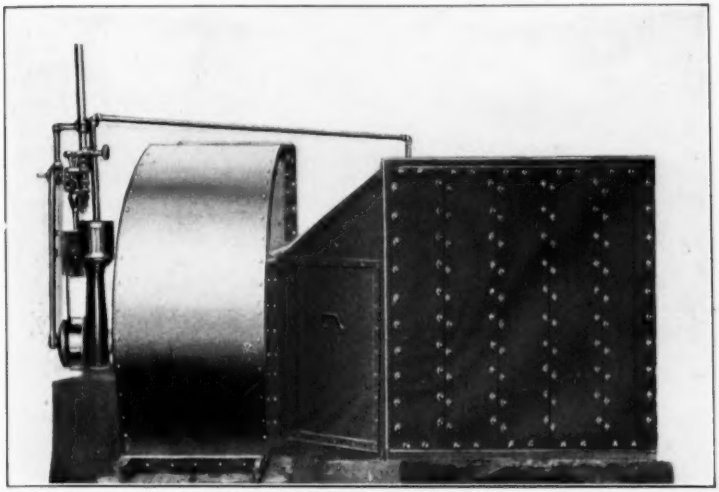
SINGLE ROUND-FLUE DAMPERS, CLOSED AND OPEN.

Operated by thermostatically controlled air-motor. The Johnson Service Co.

rooms, heating them up to such a degree as to make them unbearable. The difficulty in this case was that whenever there was the slightest wind pressure on the top of the stack, the resistance to egress around the stack of the heated air was much greater than it was into the room of the building, and of course the heated air chose the path of least resistance.

There is one feature in connection with the cooling of rooms to which attention should be directed, as it has been the cause of a great deal of trouble and the failure of cooling systems. It is a matter which is generally overlooked, because it does not enter into the consideration of heating buildings. This point is the amount of heat given out by the condensation of moisture in the atmosphere. As before stated, as the air is cooled, the moisture contained in it is condensed and deposited; and each pound of this moisture so condensed gives out approximately 1,000 B. t. u. which must be taken up by the refrigerating medium. The amount of refrigeration required to overcome this may be much greater than the amount necessary to overcome the heat radiated through walls and windows into the building and from the persons in the building. In one instance that I have in mind, where the cooling of a large store floor was planned, the number of B. t. u. required for cooling the air needed for ventilation and for replacing the heat losses through walls and windows was about 800,000 per hour, while the number of B. t. u. required because of the condensation of moisture was 1,300,000. In this particular instance, there were 1,200,000 cubic feet of air per hour which it was supposed would enter at 92 degrees F. at 95 per cent saturation, and leave at 82 degrees F. and 65 per cent

A LARGE DIAPHRAGM VALVE.
The Johnson Service Co.

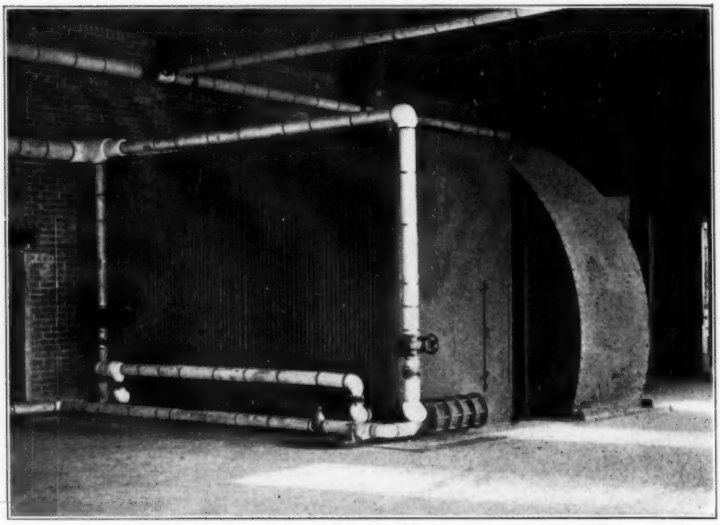


A COMPLETE HEATING AND VENTILATING OUTFIT.
The Green Fuel Economizer Co.

saturation; the amount of moisture condensed would be 1,384 pounds. These are extreme cases, but they serve to show the importance of the consideration of the humidity factor.

If a water tower is installed for cooling the circulating water, the total cost per annum, taking into account the lesser number of days in which cooling is required, compared to the number in which heating is required, would be about the same for cooling as for heating, including fixed charges on the equipment. This estimate is based on the supposition that cooling would be required for only 45 days a year, as compared with 180 days for heating. The cost of operation is, therefore, not excessive, and it is only a question of a short time before the cooling of large buildings will be as much a matter of course as their heating, particularly in climates subject to such extremes in temperatures as our own in New York.

If exhaust steam is available from an electrical plant or pumping machinery, the costs of both heating and cooling are greatly reduced through the reduction of both the fuel and labor items. The use of exhaust steam for heating is old, but its use for cooling is novel and not so widely known. It is, however, entirely practical and successful. This steam is used in the absorption system of refrigeration to evaporate and separate ammonia gas from a mixture of ammonia and water. The ammonia is then liquefied by cooling water and allowed to return to its gaseous state in the cooler and be re-absorbed in the



HEATING APPARATUS IN PAINT SHOP, N. Y., N. H. & H. R. R., READVILLE.
The B. F. Sturtevant Co.

mixture of water and ammonia in the absorber in the usual way. No high-pressure steam is required, except for a very small pump. With such a system, the cost of cooling is reduced to the fixed charges, repairs, water cost, and some labor, and this cost may be further reduced, where the number of days operation and size of plant warrant, by the installation of a cooling tower.

In every branch of science and mechanics, development has been wonderfully rapid in the past thirty years, and when a system of cooling, heating, moistening, and drying the air as described is compared with the old-time methods of isolated stoves, it is evident that the art of heating and ventilating has not stood still.

There is no reason at the present time why a building, if properly designed for the purpose, should not be maintained all the year at a comfortable, healthy temperature with air containing the proper percentage of moisture and at the same time free from dust or other impurities. The great difficulty is to persuade the owner to spend the requisite amount of money for a complete system, and to persuade the architect to adapt his building plans to allow the system to be installed perfectly. This involves usually some sacrifices in decorative effect and in available space, but from the point of view of the man who is to live or work in the completed building, these matters are of no importance when compared with the results to be obtained.

THE NEVADA COPPER FIELDS.

By A. Selwyn-Brown.

Various extensions in the use of copper as a material of construction—especially the vast and progressive expansion of the electrical industry and the application of electric power—have altogether combined to place copper in the position of a rival to iron as a "barometer of trade." It is expected by many, at least, to give a more prompt and more sensitive indication of progress in the resumption of a normal stage of industrial activity. The attention thus centered on the metal heightens interest in Mr. Selwyn-Brown's excellent review of one of the newest and most important copper-bearing regions. His clear definition of the geology will be found particularly interesting and valuable.—THE EDITORS.

IN the early mining days in the West, Nevada became famous as a great silver-producing State. The mines on the Comstock and at Eureka, Tenabo, Austin, Belmont, Ely, Golconda, Tuscarora, Candelaria, and a dozen other fields, gave employment to many thousands of men and produced immense quantities of silver ore. The decline in the value of silver early in the eighties, however, caused silver-mining operations to become unprofitable and, by degrees, the silver camps became deserted, or were continued by a few miners who were able to lead a precarious life by mining gold and other ores on a small scale. A revival of mining interest in this State was induced in 1905-7 by the rich gold discoveries in the Tonopah, Goldfield, Bullfrog and other gold-mining districts in the southern portions of the State, and the returns from these districts promise to force Nevada to the head of the gold-producing States within the next few years. But the mineral wealth of Nevada is diversified, and when the great copper plants now in course of construction are completed and run to their full capacities, Nevada will also take rank among the foremost copper-producing States. At a later date, when investors turn their attention to Nevada's wealth in zinc ores, her zinc production also will become extensive.

In the early days of mining in Nevada smelting practice was not well-known and the miners were compelled to carry out expensive furnace experiments. All over the State the remains of their plants are to be met with, and many are historically celebrated. It is generally conceded that the birth-place of American lead smelting is at Eureka, Nevada. It was there that Kustel, Stetefeldt, and other re-

nowned metallurgists developed the smelting processes that have since placed American smelting practice in advance of that of other countries. Experiments with new methods of concentrating copper, lead, and zinc ores, preparatory to smelting operations, are being carried on in various parts of Nevada which promise to work another revolution in metallurgical practice, and thus add another interesting chapter to the State's mining history.

It is proposed in this article to survey briefly the principal copper centers of the State and to describe several of the most important copper-reduction plants now in course of construction.

Topography.

Nevada consists of an immense tableland suspended on the Sierra Nevada on the west and the outlying ranges of the Rockies on the east. The elevation varies between 3,000 and 7,000 feet above sea level. The State is traversed throughout by innumerable mountain ranges having a general trend in a northeasterly direction. Arid valleys occur between the parallel ranges. There is very little natural vegetation beyond sagebrush, and stunted trees such as juniper, *piñon*, cottonwood, and pogonip or white pine, which grow in patches on the mountains a little below the snow belt. Large areas of the desert valleys, however, are very fertile when irrigated.

Geology.

The geological features of Nevada are in many respects remarkable and have inspired some of the finest geological monographs hitherto published in America. The pioneering work was done by Major Powell, Clarence King, Hague, Gilbert, Turner, Wheeler, Walcott, and Curtis. Messrs. Spurr, Rowe, Weeks, and Ball of the United States Geological Survey and Professor Lawson of the University of California, have recently published valuable geological monographs dealing with specific areas.

The most remarkable feature of the geology of Nevada is the evidence of volcanic activity everywhere visible. In places it is seen in immense sheets of volcanic rocks, intrusive dikes, or gigantic ruins of volcanic craters. In other places it is shown by gigantic fissures, the result of earthquakes, marvelous metamorphic phenomena, and immense beds of sinter and volcanic ashes. Often steaming springs and fumeroles are met with, showing that volcanic activities are still in operation, and unmistakably indicating that Nevada is still within the historic "Circle of Fire," the great volcanic belt that rims the Pacific Coasts of the Americas, as well as those of south-eastern Asia

and Australia, and continues in an undeviating course through many of the islands in the southern seas.

Investigations made by Mr. Spurr in 1900 in various districts in Nevada led him to believe that the whole of the State, as well as a large part of the Mojave desert, in California, is underlain by a single body of molten magma, which has supplied, at different periods, lavas of similar composition to all parts of the overlying surface. This great territory thus forms a single petrographic province occupied by similar rock formations. More recent researches have increased the limits of this great province and many of the best authorities on the geology of the West Coast of America are agreed that one vast petrographic province stretches from Alaska away through British Columbia, Idaho, Nevada, Arizona and Mexico, down south into the Andean regions of South America.

The general sequence of lavas in Nevada is in the following order: 1. Rhyolite, (Eocene.) 2. Andesite, (Miocene.) 3. Rhyolite and basalt, (Miocene-Pliocene.) 4. Andesite, (Late Pliocene-early Pleistocene.) 5. Basalts and occasional rhyolites (Pleistocene). This most remarkable petrographical province is accompanied by a coextensive metallographic province carrying some of the richest ore deposits hitherto discovered, and it is furthermore worthy of remark that a large proportion of these ore deposits are similar in age and in the manner of their occurrence, and have an almost identical geological history. For example:—the ore deposits of the Comstock, Tonopah, and De Lamar are, as regards their mineralization and geological history, almost identical with the ore deposits at Guanajuato, Pachuca, and other great mining districts in Mexico.

The above description of the Pacific petrographic and metallographic province will explain the similarity of the geological features of most of the mining districts in the State. If we were considering the gold-mining districts no other geological formations need be referred to than the volcanic strata named above; for it is in the rhyolite and andesite rocks that the principal gold veins are found. The great copper deposits, however, are found mostly in association with certain sedimentary rocks that require to be briefly mentioned. In White Pine County, a series of limestone formations occur in association with quartzites and siliceous and argillaceous rocks in which copper, silver, lead, zinc and other ores are present. The Nevada limestone, extensively exposed at Eureka, is over 6,000 feet in thickness and is of Devonian age. The Lone Mountain limestone formation, also well seen at Eureka, is of Silurian age and is from 1,800 to 2,000

GENERAL VIEW OF THE STEPTOE VALLEY SMELTER AND SURROUNDINGS, JULY, 1907.
Situated at McGill, 14 miles north of Ely.

STATION OF THE NEVADA NORTHERN RAILWAY AT ELY, NEVADA.

feet in thickness. The Pogonip, Prospect Mountain, Red Wall, and Wasatch limestones occupy large areas in Central Nevada. The Ogden quartzite covering the Paleozoic area west of the Wasatch Range, in Utah, occurs in many places in White Pine and Humboldt counties. Less extensive sedimentary formations will be referred to when describing the geological features of particular copper mining localities.

The Ely Copper Field.

The most promising copper-mining district in Nevada at present is at Ely, in White Pine County. It is the scene of great activity and numerous important copper-mining companies with a total capital of over $200,000,000 are developing large areas of copper-bearing land, and erecting extensive concentrating and smelting plants.

Ely is situated in the southern portion of White Pine County, in North-eastern Nevada, about 40 miles due west of the Utah boundary line. It is connected by rail with the Southern Pacific main line at Cobre. The distance by rail between Salt Lake City and Ely is about 317 miles.

The town possesses a population of about 4,000 and is nicely situated at the mouth of a cañon in the Egan range known as the

Robinson cañon. It is one of the oldest mining centers in Nevada, and has had a very checkered history. It first became prominent in 1865, shortly after the discovery, in the autumn of that year, of some very rich silver veins on the western side of Mount Pogonip, a prominent landmark in north-eastern Nevada, which rises to an elevation of 10,792 feet above sea level, and is the highest peak in the White Pine Range, running parallel to the Egan Range on the west. The main road to the White Pine mining district passed through Robinson cañon, and thus Ely became an important base of supplies for the prospectors who led to the district by stories of the fabulous richness of the Pogonip silver veins, set to work and prospected the whole of the north-eastern districts in the State. As the result of their labors, deposits of silver, gold, zinc, molybdenum, manganese, copper, opal, turquoise, sapphire, chiastolite, of more or less value, have been discovered in and around the Ely district and throughout the whole of White Pine County.

The Egan Range begins at a point a little north of the fortieth parallel, which was made celebrated by Clarence King's geological surveys for the United States Geological Exploration of the Fortieth Parallel Reports, and runs southward for a distance of 150 miles. This range is composed chiefly of a strongly defined central ridge, which, in the vicinity of Ely, is considerably disturbed by intrusive volcanic rocks. The range is cut through by several cañons, of which the Egan and Robinson are the best known. Granite of Archean age, overlain by quartzite and quartzitic schists of Cambrian age, is exposed near the eastern end of the Egan cañon. From Egan cañon south to Ely the Egan Range is composed chiefly of stratified rocks. A well-formed dike of hornblende-tonalite-porphyry runs through the strata in Robinson cañon and runs eastward with a number of similar dikes toward Howell's Peak. It has, doubtless, played an important part in the mineralization of the district.

The Ely copper deposits occur in a belt of intrusive quartz-porphyry, or monzonite. Two well-defined areas are occupied by the porphyry. One commences at Copper Flat and runs eastward for a distance of three miles to a hill called Rusty Ridge. This belt is about a mile in width. The other porphyritic area stretches from Ocher valley eastwards to the Chainman mine. It is three miles long and about three-quarters of a mile in width. The Ruth limestone and White Pine shales are the principal Palaeozoic sedimentary formations intruded by the porphyry laccolites. It was in these sedimentaries that the early gold and silver mines were operated. Roughly

speaking, the gold-bearing veins are distributed in the sedimentary formations lying to the south of the copper-bearing porphyry, while the silver-lead deposits are met with chiefly in the limestone formations on the north of the porphyry. The silver-lead-zinc-bearing Ruth limestones are of later geological age than the porphyry; the gold-bearing sedimentaries south of the porphyry are older than the copper formation.

PLANT OF THE CHAINMAN CONSOLIDATED COPPER COMPANY, ELY, NEVADA.
Taken in July, 1907. The light spot at the left is a dust whirlwind.

The porphyry is mineralized in parts only. It is a light, yellowish quartz-feldspar rock. Through its contact in a molten state with the shale and limestone formations, large bodies of quartzites and garnet rocks have been formed, which also carry chalcopyrite as a product of contact metamorphism. The porphyry has been greatly disturbed in places by faults and dikes. One of the dikes cut in the workings of the Ruth mine is found to be composed of minette carrying sapphires like a similar rock in which sapphires are mined in Montana.

The Mines at Ely.

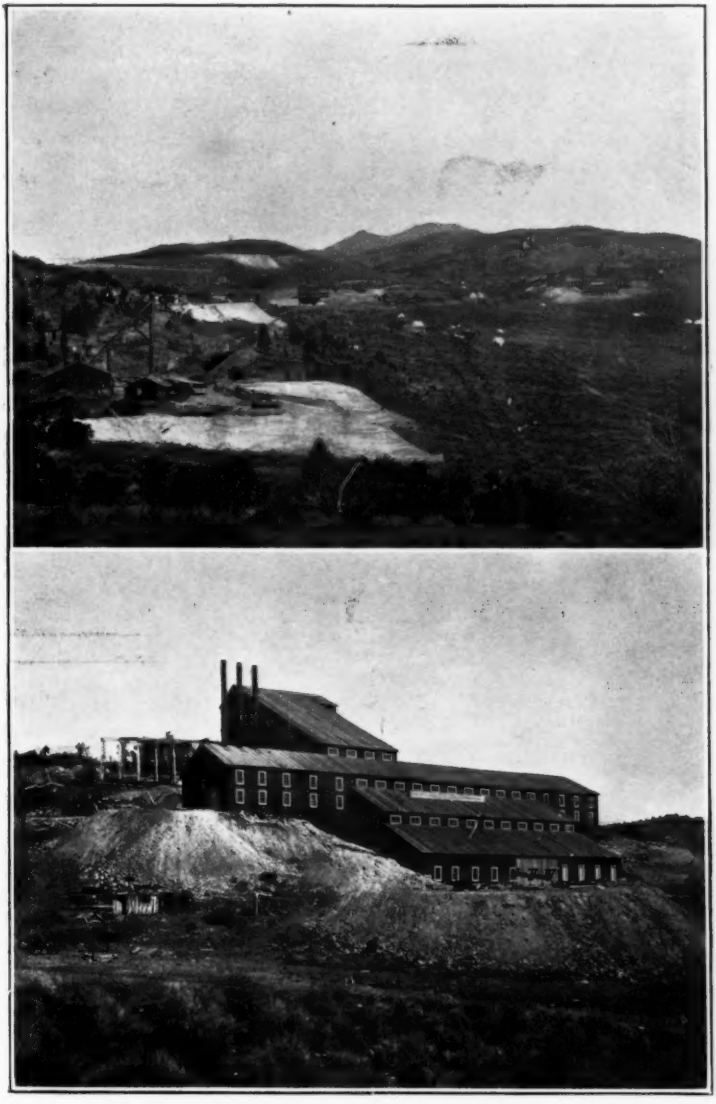
The present impetus to mining at Ely is due to the efforts of Messrs. Bradley and Requa of San Francisco, who on learning several years ago of the similarity of the copper-bearing porphyry to the Bingham porphyry in Utah, secured numerous leases and developed the ground. In 1904 they employed Professor Lawson, of the Uni-

versity of California, to survey the field geologically, and on information gained by a study of Lawson's maps and monograph very large tracts of country were leased. Shortly afterwards an era of promotion set in and the Nevada Consolidated, Giroux Consolidated, Cumberland-Ely, Ely Central, and other companies were formed to operate copper mines on the field.

OPEN CUT, EUREKA MINE OF THE NEVADA CONSOLIDATED COPPER COMPANY.
The railroad track rests on solid ore, ready for the steam shovel.

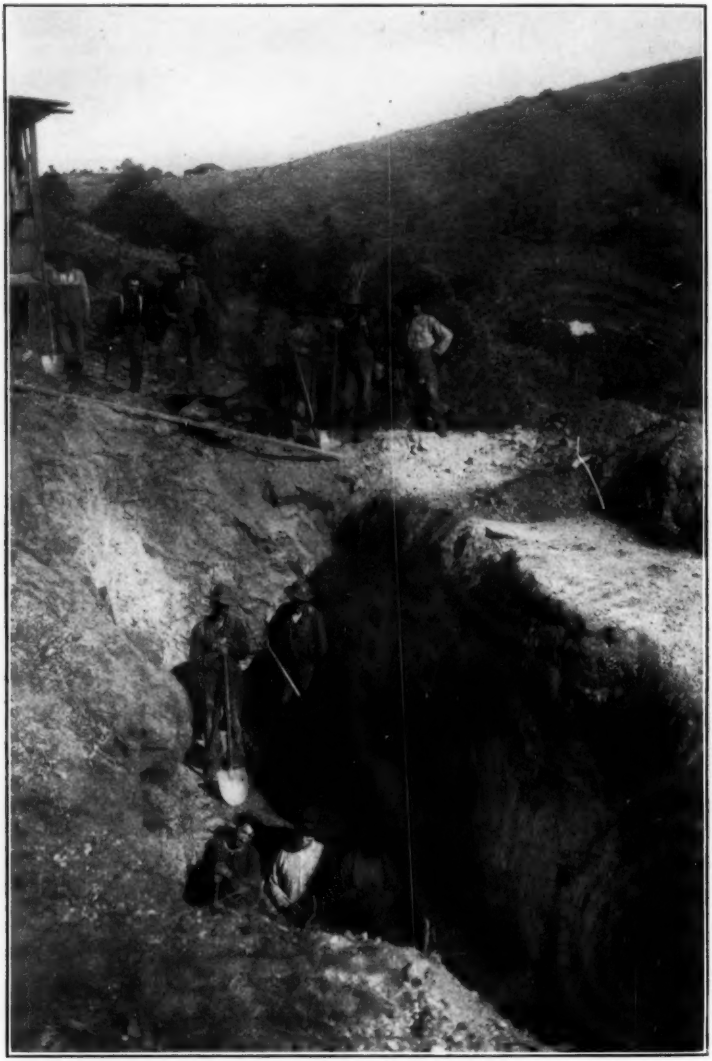
The porphyry is usually cut at a depth of from 80 to 300 feet from the surface. The ore-bearing portions have been proved to a depth of 1,600 feet and for an equal width. The average value of the ore is a little over 2½ per cent copper, or say 50 pounds of copper per ton. The cost of production is estimated at 7.03 cents per pound net, delivered in New York.

Each of the above mentioned companies has developed immense ore bodies. The ore blocked out in the Eureka and Ruth mines of the Nevada Consolidated Company alone is estimated at more than 15,000,000 tons with an average copper content of 40 pounds of copper per ton, and a little gold and silver.



BELOW, THE GIROUX CONCENTRATOR. ABOVE, THE BUTTE-ELY MINES IN THE FOREGROUND WITH THE GIROUX CONCENTRATOR IN THE DISTANCE.

Taken Oct. 29, 1907.



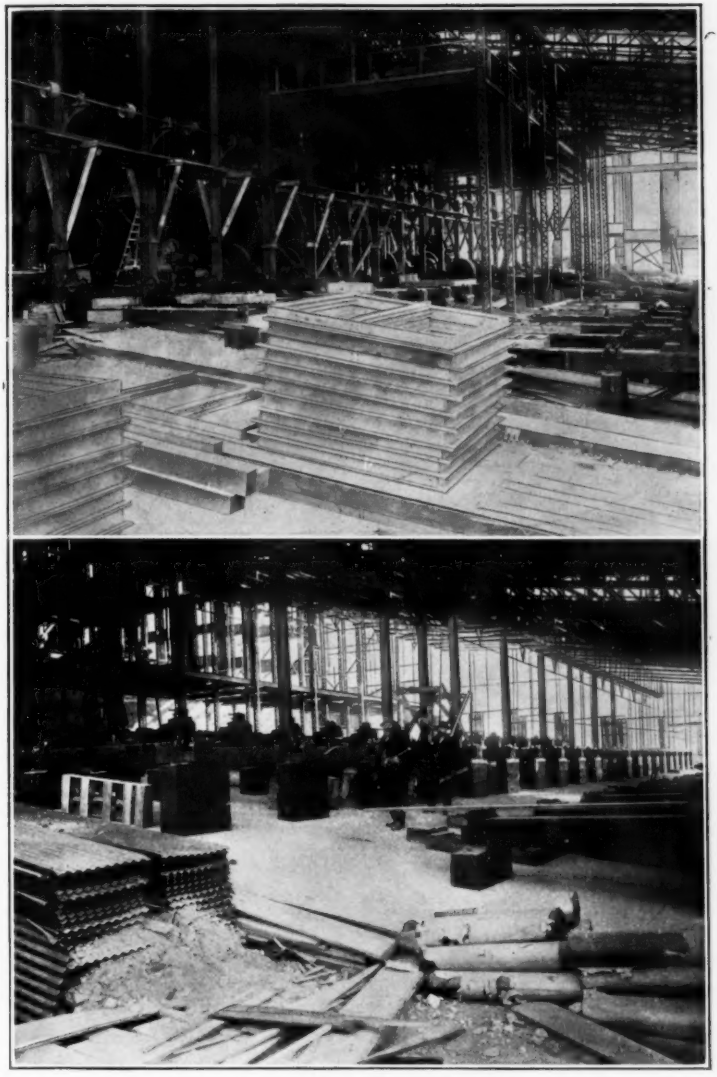
VETERAN SHAFT OF THE CUMBERLAND-ELY COPPER COMPANY.
The beginning of a four-compartment shaft; taken Oct. 31, 1907.

The Steptoe Valley Smelting and Mining Company, in which the Cumberland-Ely and Nevada Consolidated companies are interested, is building a concentrating and smelting plant at McGill, 14 miles north of Ely. An area of eight square miles has been secured for a smelter site, and the water rights over a larger area have been purchased. The directors of the company, being experienced copper smelters, secured all this land with a view of minimizing the damage done by the smelters and thus avoiding the expensive litigation which has constantly harassed the Montana and Utah smelters. The smelters will have a daily capacity from 2,000 to 5,000 tons of ore. The power plant, to furnish power for the smelter, concentrator, and mine plants, will have a capacity of 6,500 horse power. The concentrates will be treated in the smelter, which consists of roasters, reverberatories, blast furnaces and converters.

STAR POINTER SHAFT, NEVADA CONSOLIDATED COPPER COMPANY.

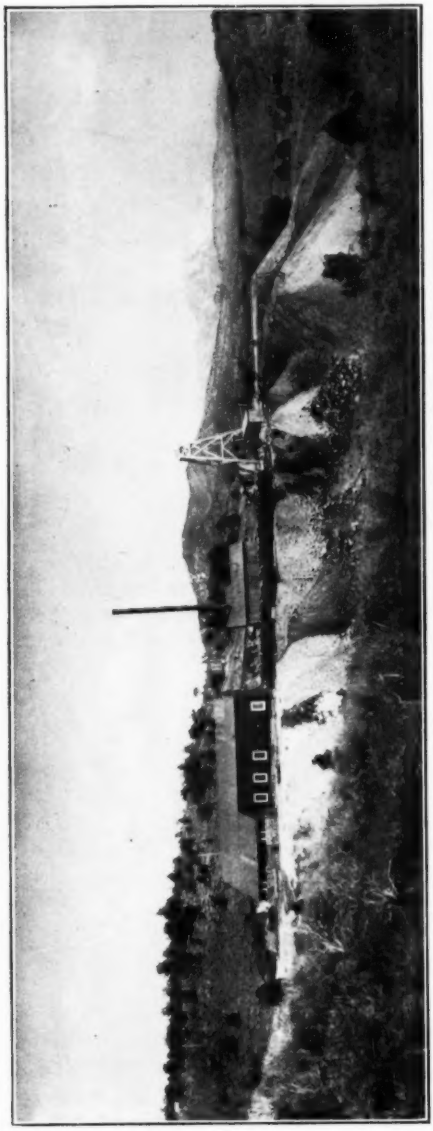
The claim area of the Nevada Consolidated Copper Company amounts to about 850 acres, consisting of 63 claims. It is divided into two general sections, the Eureka group, comprising 27 claims, and the Ruth group of 36 claims.

GENERAL VIEW OF THE STEPTOE PLANT (OWNED JOINTLY BY THE NEVADA CONSOLIDATED AND CUMBERLAND-ELY COMPANIES) TAKEN IN THE LATTER PART OF NOVEMBER.



THE THIRD AND THE UPPER WILFLEY FLOORS OF THE STEPTOE CONCENTRATOR.

Steptoe Valley Mining & Smelting Co.



ALPHA SHAFT, GIROUX CONSOLIDATED MINES CO. ONE OF THE FIVE MAIN WORKING SHAFTS.

The deepest in the district; nearing the 1,100 ft. level. Has developed large bodies of high-grade ore, and is equipped with a pumping plant of 250,000 gals. per diem capacity for supplying water for the concentrator.

The copper ore occurs mainly as chalcocite as a secondary enrichment; this chalcocite, in the form of specks, veinlets and bunches, being in the porphyry, of which there are large intrusive masses in both the Eureka and the Ruth groups. Besides copper in the form of chalcocite, there is also some chalcopyrite. Iron pyrites is associated with both minerals.

The Giroux Consolidated Company owns 52 claims comprising an area of 1,050 acres. This mine is about two miles in length and from 2,000 to 5,000 feet in width. It lies at an elevation of 7,300 feet above sea level. The mine has been developed through five shafts and the porphyry has been found ore-bearing at a depth of 1,200 feet. The company has

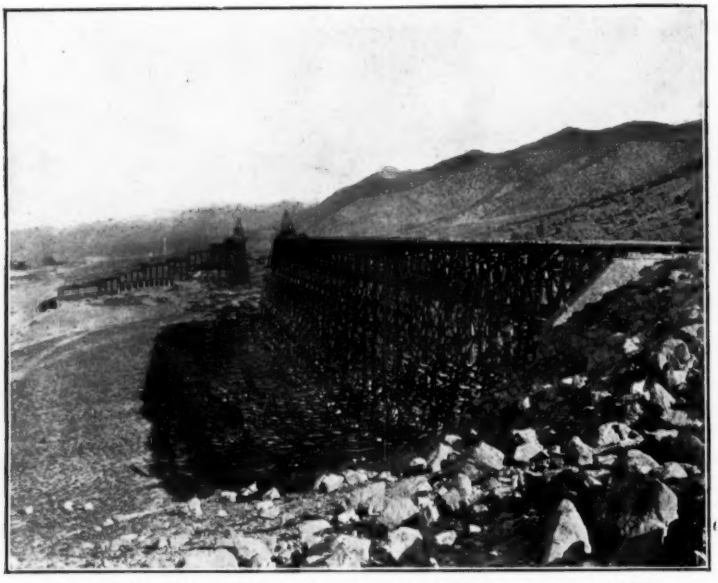
erected a concentrating and smelting plant that will shortly be working.

YERINGTON.

The mines in Douglas and Lyon Counties in the vicinity of Yerington are the next in importance to the Ely mines at present. Yerington is situated on the Walker River, about 35 miles east of the California boundary, and about 12 miles southwest of Wabuska, a station on the Carson & Colorado Railroad. The altitude of the mines is about 4,300 feet above sea level. The principal workings are situated on a portion of the Mason Valley range, which is composed of a core of granitic rocks saddled by later volcanic formations and by sedimentaries. A remarkable feature of the geology is the occurrence of a large body of garnet rock, as at Ely, which lies between the intrusive granite and the limestone. It is evidently a product of contact metamorphism. Large masses of iron are associated with the garnet rock. Close to the garnet rock, the limestone has been changed into wollastonite, fluorite, and marble in places. There is an intimate connection between the garnet rock and ore bodies. The copper ore is not found in regular lodes, but in vughs and pockets filling irregular chambers and fissures in the limestone, garnet rock and granite. It would seem that the molten mass of intrusive lava, now forming the granite, melted portions of the limestone, and on cooling, the lighter upper portion crystallized out as garnet rock. The prevailing garnet is grossularite composed of lime and alumina. This in places is changed into andralite, the iron garnet, by iron replacing the alumina. This crystallization of the garnets took place simultaneously with the mineralization of the ore bodies.

The geological features of this field very closely resemble those at Ely. But up to date the granite has not been found to carry large low-grade bodies of disseminated copper like the Ely porphyry. The copper in the Yerington mines is found in large chambers in the overlying limestone or in the granite, and in shear planes and other fractures in the garnet rock, limestone, and granite. Some immense quantities of copper ore have been blocked out for stoping in the Nevada-Douglas, Ludwig, and other leading mines and important extensions to the metallurgical plants are being planned.

In addition to the deposits at Yerington, a large amount of prospecting for copper ore is being carried on right along the Walker River, Smith Valley, Excelsior, Candelaria, White, Silver Peak and other ranges running along the boundary between Nevada and California. Copper deposits have been located in numerous places



THE STEPTOE CONCENTRATOR AND RAILROAD TRESTLE. LOOKING NORTH.

in all the above named mountains, and numerous promising copper mines are being developed. The geological features of the ranges and of the copper deposits are the same from north to south, for they lie within the petrographic and metallographic province described above. These ranges will in time become the seats of great copper-mining industries.

Belmont.

This is a famous old mining center situated at the south-eastern end of the Toquima Mountains, in Nye County, and about 50 miles north of Tonopah. The Toquima Range is composed of volcanic rock, chiefly; but in places limestone and schists occur. Near Belmont the stratified rocks, which dip at high angles, have an estimated thickness of 5,000 feet. There has been a large amount of ore deposition in the mountains, and a large amount of mining has been carried on during the past 30 years. Copper ore occurs in well-defined quartz veins traversing the sedimentary formations, and in the granite. Some of the most important mining properties in the vicinity of Belmont have been acquired by powerful financial interests lately, and it is proposed to ship the Toquima copper ores to Ely, when the proposed

Tonopah and Salt Lake Railroad, which is to pass through both Belmont and Ely, is completed.

Toyabe.

The Toyabe Mountains run parallel with the Toquima Range on its western side. They are about 100 miles in length. The mountains are composed chiefly of volcanic rock. The peaks are high and sharp, and the intervening cañons are deeply cut. The range has had a varied mining history. A large number of valuable mines have been discovered and worked at various times during the past with more or less success. At present there is little activity in this section, except in the vicinity of Austin, the oldest mining town in Nevada, where several old mines are being opened up again. Important lead and zinc deposits as well as copper deposits occur in the Toyabe Mountains.

Ellsworth.

This is an old copper-mining center, now almost abandoned, situated at the southern end of the Ellsworth Mountains, sometimes called the Desatoya Range. This is a range composed of ancient volcanic rocks and derived tuffs with numerous limestone cappings, running parallel with the Toyabe and Reese River Ranges in Central Nevada. The geological features of the district are favorable for mineral deposits, and a large number of mines have been located and prospected. At present the district is too remote from the railroad to enable the mines to be operated with profit.

Reveille.

The Reveille Mountains are in the western portion of Nye County, directly east of Tonopah. The range is composed of igneous and palaeozoic sedimentary formations, and contains valuable deposits of lead and copper. Several large mines are being developed near the town of Reveille by the Nevada Smelting and Mines Corporation, which is likewise developing valuable properties at Tybo, in the Kawich Range north-west of Reveille.

Conclusion.

Some of the most important of the copper-mining centers in Nevada have now been briefly reviewed; but many of the copper districts have not been mentioned owing to the lack of activity of the mine owners. There is hardly an important mountain range in Nevada that does not contain copper deposits of more or less economic

THE GIROUX CONCENTRATOR.

A 500-ton unit of the 1,000-ton plant, designed to treat low-grade porphyry ores.

importance. Owing, however, to the aridity of a large portion of the State, and the bad and costly transportation systems, slow progress is necessarily made in mining developments. It may, however, be confidently asserted that the immense ore reserves developed in the copper mines at Ely and Yerington alone, will assure Nevada a prominent position among the copper-producing States. It will, possibly, be two or three years before the mines are in full operation, but in that time Nevada will, doubtless, equal Utah in copper production. Then the success of her gold and copper-mining industries will draw attention to her other metallic wealth and consequently enhance the importance of the Cinderella State. Thus past neglect will be atoned for.

A SIMPLE SYSTEM OF RECORDING SHOP COSTS.

By C. J. Redding.

In the following article Mr. Redding outlines a system that has proved successful in an English works employing three thousand men. The most noteworthy feature of the system is the use made of a preliminary "shop summary." These shop summaries are in reality a specification of processes by which the course of the work is mapped out in advance. They represent a growing practice in some of the most advanced shops and will be adopted sooner or later as the proper starting point for all shop costs. Mr. Redding demonstrates their value from more than one point of view.—THE EDITORS.

THE success of every cost system depends on the accuracy with which the workman's time is recorded. The significance of this truth is not properly appreciated by most managers. Many works are equipped with elaborate systems for collecting the costs of material, but that of the wages is often relegated to the background, as being of no great importance. How great a mistake this is soon appears when these costs are examined by a practical person, the wages charged for some parts proving too high, for others far too low. The result of such an examination is a general condemnation of the whole system and no confidence is placed in any future costs. The wages side of cost-keeping is the most important, and this fact must be realised by any man who thinks about it at all. It seems to be the general opinion that any one is capable of taking a man's time. This idea is quite right if the system is a good one, but if it is not, then only the very best men obtainable are good enough to be time takers.

The object of a cost system is to obtain the cost of an order; but how much more valuable is the system when the cost of each detail of the order is also obtained. The more detailed manner in which the men's time is recorded, the better are the results. With this object in view I propose to explain a system which I have worked successfully for some time in a large engineering works employing about 3,000 hands.

In many works time takers are employed to record the men's time; in others the men record their own, on time sheets, etc. Both systems are good, as long as the time takers and the men each do

their part faithfully, but experience has demonstrated that neither is good enough for an up-to-date works, in which facts alone are required.

Many managers and foremen point to the time wasted by the workmen recording their time, and are convinced of the economy of time takers. Is the workman's time saved by employing time takers? When the time taker arrives the man does not go on working, but stops immediately and proceeds to tell him all he has done, and probably dilates on the weather or some other subject as well. From long observation of time-taking methods I have come to the conclusion that more mistakes are made when time takers are employed than when the men record their own time.

Another point against time takers is that the men bear no responsibility for the accuracy of the time recorded. They know quite well that, in case any time is questioned, they can say the time taker has made a mistake and put down the time wrong. There can be no appeal for the time takers, as it is only a case of one man's word against another's. After all, when one time taker has to take a number of men's time, and he happens to be behind-hand in doing it, it is only human nature to economise work as much as possible. Take any works where time takers are employed, and examine the time books. See how many jobs each man is engaged on each day for the first three days of the week; then see how many there are for the last three days, but more especially the last one. I have often looked through these time books, and always thought it a remarkable coincidence that on the last day of the week nearly every man was engaged on one job only, for the entire day. This result speaks for itself, and in my opinion deals a fatal blow at any system which employs time takers alone to record the men's time.

The old method of making the men make out their own time sheet was costly, and the foremen were justified in drawing attention to the expense. One man often made up the time sheets for five or six, with the result that a lot of time was wasted, but no means were given to the men to lessen the time taken in making out the time sheets. These are some of the arguments against the men recording their own time. Give the men every facility for recording their time, and the result is all that can be desired.*

* An interesting mode recently advanced in the United States substitutes an annunciator system for the time taker. The workman rings up his starting and stopping times on the annunciator, the job ticket being stamped at the signal by a cost clerk at the central office and the elapsed time noted with the aid of the calculagraph.

These facilities are practically the combination of workmen and time takers, and the system evolved is undoubtedly the best from every point of view. The results obtained soon furnish the proof of this statement and are summed up in the three essentials for every business—accuracy, speed, and economy.

When this combination is worked the number of jobs a man is engaged upon on the last day of the week is just about the same as on the first or any of the other days. This system is as follows:—

Each department of the works is supplied with cards called "shop summary cards" ruled and printed as shewn:—

SHOP SUMMARY CARD

FOR ORDER.....

Tracing No._____ Received in Shop_____

Reference	No. Off	Description	Operation	Man's Name	Man's No.	Date Begun	Date Finished	Total Hours

The Engineering Magazine

THE SHOP SUMMARY CARD.

As soon as an order or drawing is received in the shop, the foreman or some capable person examines it and then proceeds to fill up a shop summary card for it. He writes down the order number, tracing number, and date the drawing was received in the shop, and copies each reference letter with its description on the card, leaving spaces after each reference in which to place the various operations each has to undergo in its course through that department. Consequently each shop summary card will contain the order number, tracing number, and all the details on it, with the reference letter of each and all the operations shewn on the tracing. By this means the manager is assured that each tracing, on its appearance in the

shop, has had the close attention of the foreman. The foreman can thus arrange his work to the best advantage and small details are not overlooked as otherwise so often happens to great annoyance.

In the case of an order for a standard part which does not require a drawing, the person responsible must deal with this in the same manner as if one had been sent into the shop for it. He must shew each detail with the necessary operations to each, on the shop summary card. Many managers may say that they cannot have their foreman's time taken up by this work, but if they go carefully into the question and examine the various advantages to be obtained they will soon come to the conclusion that it is time well spent. If each tracing is examined properly on its receipt in the shop and the foreman makes out the shop summary card at once, it is really surprising how little time is required. It is not advisable to let the tracings wait till a number have to be done, as this leads to a superficial inspection only. They should be done immediately they are received in the shop. If it is found inconvenient for the foreman to do this work, some other capable person, who knows the work and the shop, can do it equally as well, but it is better in all respects for the foreman to do it.

Strict instructions must now be given that no workman may start a job without a work card, obtained from the shop office. To this end the foremen are provided with small note books, in which all the leaves are perforated. These books must be of a convenient size so that they may be carried in the pocket. They are ruled and printed as shewn:—

..... Shop.

Give Man's Name..... Shop No.....

Work Card for Order No.....

Tracing No..... Reference.....

Operation to be done: Bore, Turn, Face, Screw, Grind, Plane, Mill, Shape, Slot, Drill, Polish, Fit, Erect, Test, Disconnect.

Part to be done.....

.....

Date..... Signed .....
Foreman.

FOREMAN'S NOTE BOOK FOR JOB ORDERS.

When the foreman gives the workman a job, he must also give him a note from this pocketbook. This note must have all the blanks shewn on the specimen filled in. It is only necessary to put a pencil mark through or under the operation he requires the workman to do. After the man has received this note he must send it by a laborer or messenger boy to the shop clerk. The workmen should be notified that they are not allowed to go to the clerk for these work cards. Any excuse of this nature for being away from their machine should never be accepted.

On receiving the note from the workman the clerk finds the shop summary card for that particular tracing for order number shewn on the note. He then places on the shop summary card, against the operation called for on the note, the man's name and number, also the date. He then makes out a work card for the man, giving the necessary information to enable the part to be identified. These work cards are ruled and printed as shewn:—

..... Shop.

Work Card for Order No..... Man's No.....

Tracing No..... Reference.....

Date begun .....

Work ordered.

Piece-Work Price £.....

Day work.

On completion of work this card must be defaced with an × placed across face.

Signed .....

Date	Hours	Date	Hours	Date	Hours	Date	Hours
		Brought Forward		Brought Forward		Brought Forward	
						TOTAL—	

THE WORK CARD.

The shop summary card contains all the information required by the clerk to enable him to fill up all the blanks (except the hours) on these work cards. No work cards may be given out by the clerk without having all these requirements fulfilled. He must also be clearly instructed that no work cards may be made out until he has filled in the man's name and number and date on the shop summary card against the work to be ordered on the work card, as shewn on the note received from the workman. This is absolutely necessary in order that the shop summary cards shall be complete in every detail, and that every work card may be traced in case it has not been returned to the office. It must also be clearly understood by the workmen that no time will be paid for unless a work card has been obtained for the work entailing the expenditure of that time. This is of vital importance and must be rigidly enforced. These work cards may be sent to the workmen by the messenger boys, periodically through the day, but in every case, all cards must be delivered to the men at least half an hour before leaving off time. A separate work card must be given to the man for each job he is engaged on. Each workman now has a work card giving the order number and all the necessary information required to identify and do the work ordered. Each day before leaving off work he must record on these cards the date and the hours he has spent on that particular date doing the work ordered on each card.

These cards are then placed in suitable boxes fixed in a convenient place in the shop so that no time may be lost by the men in putting their cards in them.

All cards for work which has been completed must be defaced by the workman with an X placed across the whole face of the cards, so that the time taker can see at a glance that the order is completed. This cross must be placed only on completed work cards.

Every morning on starting work the time takers collect the cards from the boxes and place them in rotation according to the men's shop numbers. They then check the total day's time charged by the men on the cards, with that recorded by the timekeeper, making any necessary corrections on the cards. They then copy into the time books (which are ruled and printed as shewn), the time of each man, giving the order number, tracing number, reference, description of the work, with the operation, all as recorded on the work cards.

After this has been done the time books are called over with the work cards thus checking the accuracy of the entries. At the end of each week these time books are signed by the person calling over as having been examined and found correct.

Name ---------- Man's No. ----------

Rate ----------

Order No.	Tracing & Reference	Description of Work	Daily Time								Total Time	Amount of Wages	Remarks
			Wed. Night	Th.	Fr.	Sat.	Mon.	Tue.	Wed.				

look on mechanical time recorders as machines to be "done," if possible, much in the same way as some people regard the automatic machines at the railway stations.

All completed cards are now cast by the time takers and the total hours placed in the total column. These cards are then returned to the shop-office clerk who enters these totals, together with the date the work was completed, on the shop summary cards, covering the work ordered on the work cards. This work must be done immediately by the clerk and must never be allowed to get in arrears on any consideration.

At the end of the week, in order that no time may be lost in the cost department, the time takers collect the cards after the men leave off work, and stop overtime that night doing the work which they usually do the next morning. They also cast the hours of each man in the time books and place the total hours spent on each job in the columns provided, and the grand total of hours for each man for the week. These time books are then rated and the total hours on each job extended at the rate of pay of each man. The total wages of each man are then obtained and agreed with the pay roll of the shop.

To insure proper attention one time taker should be employed for every 300 men. This is a reasonable ratio and should ensure accuracy. In the case of any shop having a number of men engaged on small work, or in which a number of orders are in progress at the same time, this ratio of course must be lowered, and vice versa. Experience will soon fix the proper amount of work for each time taker. As this work is only copying, smart lads may with advantage be employed to do it. It should be the stepping stone to a better position for them. As vacancies occur in the office, those lads showing most promise should be promoted to fill them. The training as time takers would come in very useful for them on their promotion and would be advantageous to the firm because of their familiarity with the technical names and of the processes each part undergoes during the course of its construction in the shops. This is a great item to be considered with new clerks, who as a rule are of very little use in a works for some months.

To ensure that the time books are checked daily with the work cards, it is advisable that an independent person should periodically see that this has been done. This will tend to make the time takers careful in their daily checking of the time books.

The shop clerk may give only one work card to a man for any one operation on any one part of an order. When the order calls

for a number of parts off the same pattern, then any one operation on all these parts may be ordered on one work card. For instance:— supposing an order called for twelve connecting rods off tracing number —; then a work card should be made out for turning the twelve rods, provided one man was going to do the whole lot; if more than one man would be engaged on the turning of the twelve rods, then as many work cards must be made out for the turning as there are men engaged on it. It must be clearly shewn on the work cards, and the shop summary cards, how many rods each man has orders to do. The planing, slotting, milling, drilling, etc., of these rods must be carried out in the same manner as the turning.

Another instance of what is required in the matter of work cards is this:— An order is received for three stop valves; separate work cards would have to be made out for boring and turning the three bodies, boring and turning three covers, boring and turning three hand wheels, turning and screwing three spindles, and so on. One work card should not be made out for all the lathe work for all the parts of the stop valves, but separate cards for each operation on each of the parts comprising the valves.

In the case of men engaged on the "marking out" slab it is only necessary to give a work card for all the "marking out" on each order number. It is almost impossible for these men's time to be charged directly to each detail of the order. In any case, it would cost far more to record this time than it would be worth. The same applies in some cases to drillers on very small work such as pin holes, etc.

These exceptions must be thoroughly studied and rules laid down to cover the extent of these "omnibus" cards.

Practice will soon determine into what detail it is advisable to divide the work. It should, however, not be forgotten that the greater the detail the better the result from a cost standpoint. Increases in costs can be more readily discovered if the detail is great and thus be more easily dealt with.

As each operation on a part is finished, the time charged by the workman is entered every day by the shop clerk on the shop summary card. Under these circumstances only one card can be given by the clerk for any one operation on a part, because he has instructions that a work card must not be made out until he has entered on the shop summary card the man's number and the date, and if he were asked for a work card for an operation on a part against which the columns for the man's number and date in the shop summary card

were filled up, he would see at once that something was wrong as he could not fill in these columns again. In this case he would see the foreman at once and get an explanation. It would probably be caused by the part having to be replaced owing to bad work or material. If this were so, the foreman would then add, to the shop summary card for that order, the part which was replaced, entering all the operations to be performed on it, and marking it "spoiled work."

If the operation is piece work, it will be seen from the above that it is an impossibility, unless there be gross carelessness on the part of the clerk, for a man to be paid twice for the same operation on a part. It is not altogether an unheard of occurrence for a man to be paid more than once for the same work. Again, if an order calls for fifty articles and the operators on these are piece workers, it is also impossible for the men to be paid for more articles than are actually ordered, because the number of articles to be done is shewn on the work cards and consequently on the shop summary cards. If the clerk were asked for work cards for more than the fifty articles he must of necessity see that something was wrong and would then get an explanation. In how many factories can such a statement be made with confidence? How often are the men paid for more articles than are actually sent into the shop? Many cases have happened in my own experience where such payments have been made.

With this system the foreman has a record every day of every operation that is finished on each order. He can easily see by examining the shop summary cards how each part of any order is progressing, and by noticing the blanks in the hours columns he can see which operations are "hanging fire." If he went at once to the men, to whom the orders for these operations were given, he could tell if there were good reasons for the delay. Idle men would thus be soon found out and brought into line or discharged, as the case might be.

It would be an assistance if the clerk made a return daily or weekly, as might be determined, of the blanks in the hours columns of all shop summary cards. The foreman would thus have his attention drawn to those operations and could arrange accordingly.

Again, when an order is approaching completion, the clerk should make a return to the foreman of all tracing numbers with the reference letters and description of any parts, shewn on the shop summary cards, against which the number and date columns are not filled up. By this means no details ordered on a tracing are likely to be missed, because the foreman with this return in front of him can inform the necessary people so that these details may be sent into his

shop without further delay. This would stop any short shipments of orders, owing to parts being overlooked in other departments.

When an order is completed, the clerk refers to the shop summary card and if there be any blanks he must immediately go to the workmen who had the orders for the operations against which the columns are filled up, and enquire why the cards have not been returned. It is very probable first that several blanks will be seen on the summary work cards after an order is completed. In nearly every case it will be found they are due to the fact that the workmen omitted to deface the work card when the work was completed; consequently they were returned to the men, instead of the clerk. If the foreman takes this matter up, strictly, with these men it will not occur very often. It should however be explained to the men that severe notice will be taken of any men making a practice of such carelessness.

Should a workman lose his work card, the clerk must obtain from the cost department the total hours charged on that operation prior to the loss and place it on the new work card before giving it to the man. This is necessary in order that the total hours shewn on the shop summary card shall be the actual time paid for.

If an order be completed and there are blanks in the shop summary cards which are not filled up (owing to the men losing or destroying the undefaced completed work cards which had been returned to them), the clerk must obtain, from the cost department, the total hours charged by these men on the operations and place them in the proper columns of the summary cards. When this system is in proper working order the foreman has a record of the time spent on each operation on every part shewn on the tracings of all orders. How important this is, in the case of repeat orders, every manager must admit. It is a great incentive to the foreman to beat his previous record and thus reduce costs.

The foreman can see every day how each order is progressing and average his work accordingly. He can easily "get in touch" with every man who is "hanging on to his job" and thus stop such behaviour. He can be sure he is not paying twice for the same thing, nor yet for more work than is actually done, and thus he has no occasion to do detective's work.

By having to examine each tracing on its receipt in the shop, he becomes familiar with the work required and thus has no occasion to be repeatedly turning up the tracing to see what is wanted.

He knows that all details will come along in the usual course,

consequently has no need to bother about them. If they don't he knows he will be advised in good time.

Any questions which the manager may ask as to the condition of any order in the shop may be answered correctly by the clerk, who has all the necessary information in front of him. Under these circumstances the foreman has no need to draw on his imagination to try and answer the manager satisfactorily and thus avoid any unpleasantness.

The manager can see for himself how every order is progressing, and at the same time, if not satisfied with the time charged by the men, he can take up the matter in a sensible manner with the foreman because he has all the facts in front of him.

The men will see that it is not advisable to "hang on to a job," consequently the work will be done more quickly.

As the foreman will have all these shop summary cards in his possession, he can, when repeat orders come along, produce them with all the time records. Therefore when the hours charged by a man on any part are not satisfactory and the matter is taken up with him, the workman can see for himself that he is not being asked to do any more than has already been done. The men see they are not being imposed on and a good tone will soon prevail in that shop. This alone would more than pay for any expense the system might cause, without taking into consideration any of the advantages mentioned above.

In conclusion, for this system to be a success no deviation from the following general rules must be allowed on any consideration:—

1.—The foreman must make out the shop summary card as soon as the tracing or order is received in the shop.

2.—The clerk must not make out a work card before consulting and filling in the columns of the shop summary card.

3.—No workman shall be allowed to do any work without a work card.

4.—A workman shall be paid only for the time charged on his work card after it has been agreed with the timekeeper's records.

The above are the fundamental rules of the system, and if they be carried out in the manner explained in this article, the manager can rely on having a thoroughly practical time-recording system, from which the advantages obtained, and the satisfaction he will feel, will more than repay him for the trifling expenses he may be put to in instituting it.

WATER FOR ECONOMICAL STEAM GENERATION.

By J. C. Wm. Greth.

Mr. Greth treats his topic from the point of view most important to the power-plant owner and manager—the point also from which it is generally most difficult to get a true perspective; that is, the actual saving, in pounds of coal and in money, which can be counted upon in ordinary practice. In the following pages and yet more fully in a second article to be published next month, he gives the figures from a number of working stations, taken under regular operating conditions and covering periods sufficiently long to make the results a true average.—THE EDITORS.

WATER is the most abundant of all substances and the one most used—the greatest solvent known, and plays an important part in all the process of life and industry.

Natural waters are rarely, if ever, pure; the impurities may be divided into two classes—insoluble and soluble. The insoluble impurities can be removed by sedimentation or filtration. The soluble impurities cannot be removed unless they can first be thrown into suspension, and then removed by sedimentation or filtration.

The impurities in a water used for manufacturing purposes affect all the processes in which it is used by decreasing the output, contaminating it, and increasing the cost of production; such instances occur in the tanning processes on account of the loss of tannic acid due to lime and magnesia salts, and in all scouring and washing processes where soap is destroyed by the soluble salts of lime and magnesia. In nearly every industrial or domestic use the impurities in water cause enormous waste and expense. The losses due to the incrustation and corrosion of steam-generating apparatus amount to many millions of dollars annually.

Natural waters fed into steam boilers are taken from all sources. The relative degrees of purity of natural water supplies may be stated as follows:—

Rain water or melted snow.

The waters of creeks, rivers and lakes.

Well water.

Water of mineral springs.

Sea water.

The amount and kind of impurities in a water play an important part in the economical operation of a steam boiler. A steam boiler

fed with a clear water low in scale-forming substances and free from corroding substances will last almost indefinitely without cleaning or repairs. On the other hand, a boiler fed with a water containing incrusting solids must frequently be cleaned in order that steam can be made at all, as the scale formed is constantly accumulating, reducing the efficiency of the boiler and increasing the repairs, due to the higher temperature to which the metal must be raised to generate the same quantity of steam as with a clean boiler. Corrosive substances, also, increase repairs and materially shorten the life of the boiler. When both corroding and incrusting substances are present in a water, the scale formed on the surface conceals the corrosive action going on underneath it, and the disintegration of the boiler is not detected until the damage is done.

To obtain a natural water supply practically free from incrusting solids and corrosive substances is next to impossible. Very few natural supplies can be fed into a boiler without loss, from the following causes:—

First: Loss by waste of fuel, due to scale reducing the efficiency of the boiler. It is almost impossible to determine this loss accurately since it varies with the thickness and composition of the scale. All sorts of tables (some of them on good authority) have been published, but the only way to determine the actual fuel loss is to operate the same boiler under exactly the same conditions with and without scale.

Second: Loss due to labor required for cleaning heaters, piping, and boilers. In the average steam plant the money expended for this purpose alone is more than would be the interest on an investment for obtaining a good water supply.

Third: Loss due to the investment in spare boilers to be put in commission when it is necessary to take boilers out of service for cleaning or repairs.

Fourth: Loss due to cost of boiler compounds. Boiler compounds, if efficient, are irrational in application, and at best only increase the density of the water by throwing into suspension the scale-forming substances together with the compound introduced, making it necessary to generate steam from a water having in suspension a muddy, insoluble mass, which has no place in a boiler.

Fifth: Loss due to repairs to boilers necessitated by their being subjected to overheating from the insulating effect of scale-covering the heating surface, or to the action of corrosive substances pitting and corroding the tubes and shell.

Sixth: Loss of fuel due to heat lost in cooling a boiler for cleaning or repairs and that required to bring it again to steaming heat.

Seventh: Loss due to reduced efficiency of heaters and economizers, resulting in reduced temperature of feed water, which materially increases fuel consumption.

Eighth: Loss due to cost of city water over cost of pumping and softening an available supply.

Ninth: Cost of tube-cleaning machines, repairs to them, interest and depreciation on the money invested, and labor and power required for operating them.

Tenth: Loss of efficiency and earning power of improved furnaces and stokers installed to increase evaporation, which correspondingly increases the concentration of impurities, thus forming a greater deposit of scale or producing more active corrosion, and hence a great reduction in the efficiency or life of the boilers.

Eleventh: Loss due to cost of skimmers, surface blow-offs, and other mechanical devices for preventing scale in boilers, as well as loss of water and heat.

The formation of scale in a boiler is due to two causes:—

First: the water at the increased temperature loses its power of holding in solution the scale-forming substances.

Second: the evaporation of the pure water into steam concentrates the impurities in the water remaining until it eventually becomes supersaturated, when the impurities in excess crystallize or otherwise deposit.

Impurities in solution, although small in amount (even in a bad water) as compared with the volume of water holding them in solution, will form scale because the concentration taking place in the boiler cannot be prevented no matter how frequently a boiler is blown off. For instance a 100 horse-power return-tubular boiler (say 66 inches in diameter by 16 feet long, with 98 3-inch tubes) which holds about 1,600 gallons of water, if evaporating 400 gallons of water per hour (basis of 33 1-3 pounds, or 4 gallons per horse-power per hour) having in solution 30 grains of scale-forming substances per United States gallon, if all of it remains in solution, will have at the end of 4 hours 60 grains, and at the end of 8 hours 90 grains, and so on.

The table on the following page will give some idea of the scale deposited in a boiler by waters containing different amounts of scale-forming substances in solution. From the figures any one can readily see why so large an amount of scale is deposited in boilers. The thickness of scale deposited in a boiler in a given time depends, first, on the amount of scale-forming substances contained in the feed water; second, on the ratio between the surfaces of the boiler and the volume of

water contained therein. The modern water-tube boilers contain a considerably smaller water space than fire-tube boilers, hence greater concentration occurs in a given period of time and a thicker scale is the result on account of the smaller surface which receives the deposit.

IN A 100 HORSE-POWER BOILER EVAPORATING 400 GALLONS OF WATER PER HOUR.

Grains per U. S. Gallon.	24 hours.	6 days, 24 hrs. per day.	Month, 25 days.	Year, 300 days.
15 grains	20.6 lb.	123.6 lb.	515 lb.	6180 lb.
20 "	27.4 "	164.4 "	685 "	8220 "
30 "	41.2 "	247.2 "	1030 "	12360 "
40 "	54.8 "	328.8 "	1370 "	16440 "
50 "	68.6 "	411.6 "	1715 "	20580 "

Among the methods employed for the purification of water for boiler feed are exhaust- and live-steam heaters, which have for their object the precipitation of the scale-forming substances in the heater instead of in the boiler. Practice has proved, however, that these devices cannot do more than partially accomplish the removal of incrusting substances, and that neither one will prevent the accumulation of scale in a boiler; therefore, when they are used, the cleaning of the boiler as well as the heater becomes a necessity. This type of apparatus is rarely, if ever, built large enough to allow for complete precipitation to take place. It is impossible to obtain complete precipitation by means of heat alone in any apparatus, inasmuch as complete precipitation cannot be accomplished by heat without concentration, which cannot be effected in any type of feed-water heater.

A feed-water heater in its function of imparting heat from the steam to the water is essential in any power plant, but the maximum of temperature can be obtained only when the heater is kept perfectly clean; therefore, when it is used as a purifier for precipitating and collecting impurities, its efficiency is reduced in direct proportion to the amount of impurities deposited. Every degree of temperature lost through inefficiency of the heater must be compensated for by heat under the boiler, which means an increased consumption of fuel.

Surface condensers are frequently installed to obtain a good boiler-feed water by using the condensed steam for that purpose, but this is accomplished only with steam from turbine engines, and when used in connection with other types of engines is open to several objections. It is practically impossible to remove all the oil from the exhaust steam or condensed water by mechanical devices, as the oil forms an emulsion with the water which can be separated only by means of chemical treatment or continued boiling and skimming. If the oil is allowed to enter the boilers together with the scale-forming substances in the make-up water (the addition of which is necessary

because it is impossible to condense all the steam to return it) it is apt to cause a dangerous condition, due to the non-conducting film of oil likely to be deposited and also to the scale-forming substances held by it. In many power plants operating with surface condensers the condensed steam is thrown away on account of the oil it contains. Another objection is that of keeping of the condensing apparatus in efficient service, especially when the water used for condensing contains carbonates of lime and magnesia in solution.

A surface condenser has its own office to perform, and unless the conditions as to oil-removal and make-up water are properly met, the use of this apparatus does not afford a satisfactory means of obtaining a good boiler-feed water.

The method which gives ideal results in purifying boiler feed water is that which brings about the removal of the scale-forming and corrodng substances by chemical treatment with exact quantities of predetermined reagents for their precipitation; the precipitates are then removed by sedimentation and filtration. The apparatus used is called a water-softening and purifying system.

There are two distinct types of such systems—the "intermittent" and the "continuous." There are on the market numerous intermittent and continuous systems. In the strictly intermittent system, known quantities of water are treated with the exact amount of reagents, time is allowed for sedimentation, and perfect clarification is effected by filtration. In other intermittent systems the reagents are introduced proportionally (as in a continuous system) while the water flows into settling tanks which are used alternately. In the continuous systems the reagents are introduced by proportional feed devices actuated by the water entering the system; the water enters either at the top or bottom and flows out by displacement at the same rate at which it enters. In the intermittent system definite quantities of water are treated, so that no matter how variable a source of supply may be, accurate treatment can always be made. The intermittent system, too, is independent of the rate at which the water is used. In the continuous system, the reagents being introduced by proportional feed devices, with a variable water supply and wide variations in the quantity used, it is difficult to get accurate results, and for the best results accurate treatment is essential. Either system, however, when properly designed and operated will give a soft, clear, boiler-feed water.

A water-softening system in order to give the best results must be designed to meet the specific conditions under which it is to be oper-

ated, as well as the kind of water to be treated; when properly designed and operated the reduction of scale-forming substances will be such that no scale can accumulate, all corroding substances will be removed, and the purified water will be perfectly clear. The reduction of the scale-forming substances to 5 grains will usually make a satisfactory boiler water. There are, however, many cases where it is necessary to reduce the scale-forming substances to less than 3 grains to prevent the accumulation of scale; and others where good results are obtained with 6 grains. It is impossible to remove from a water all the scale-forming substances, as calcium carbonate and magnesium hydrate are slightly soluble, nor is it possible to remove from a water any sodium salts; these cannot be removed except by distillation. All sodium salts are soluble and no chemical treatment will throw them into suspension, consequently they cannot be removed by sedimentation or filtration. Sodium salts in a properly treated water do not work any harm to the boiler, as they are neutral, non-corrosive and non-scaling.

As a general rule, anyone investigating the subject or desiring to install a system should consult a reliable manufacturer of this class of apparatus, whose business it is to install these systems and whose reputation depends on the results obtained with them.

A water-softening system to give the best results must comply with the following requirements. (A properly designed intermittent system meets them all and a properly designed continuous system meets them approximately.)

1.—Accurate chemical treatment:—the introduction of the proper reagents in exact quantities required to react with the impurities in the water.

2.—Thorough mixture of reagents with the water:—in order that chemical reaction will take place the reagents must be thoroughly mixed with the water.

3.—Accelerated chemical reaction:—this is brought about by thorough mixture and by mixing the sludge of previous softening with the new finely divided precipitate, and by heating the water if the nature of the water is such that heat is required to complete the chemical reaction.

4.—Complete chemical reaction:—which is brought about by a thorough mixture of the reagents with the water and by having the apparatus large enough to allow sufficient time for all the reactions to take place, and the apparatus so designed that every part of it is effective.

5.—Rapid sedimentation:—this takes place when the new finely divided precipitate is weighted by the sludge of previous precipitaton, causing it to settle more rapidly and perfectly.

6.—Perfect clarification:—this is accomplished by allowing time for sedimentation and final clarification by perfect filtration.

Possbly the best way to show the various effects of different water supplies would be to make use of some figures which I have at hand concerning two plants, one operating with a natural supply almost ideally adapted as a boiler-feed water, the water in question being a city water taken from a mountain stream, and the other plant operating with a well water to save the cost of city water. Later, the plant using the well water installed a water-softening system. Both plants operate 500 horse-power boilers, each consisting of four 125 horse-power return-tubular boilers of practically the same design. For convenience, the plant using city water, which is a clear soft water, will be indicated by "A," the plant using the well water by "B," and the same plant later using a water softened before being fed into the boilers by "C." The statement on the next page shows the cost of operation of the two boiler plants exclusive of fuel used per year.

It will be readily apparent to anyone from the statements given that the ideal condition of affairs is a natural soft, clear water. However, on account of the cost of the city water, plant "C" operating with the softened well water is by far the best. The plants "A" and "B" of course are not operating under exactly the same conditions. Plant "B" was used as a standard, the same prices for labor and material applied throughout, so as to get a comparison of expenditure on the same basis. Fuel saving was not taken into consideration, except that used for heating to steam boilers cooled for cleaning. It was impossible to obtain a record of the fuel used inasmuch as in plant "B" fuel was used for other purposes than for the boilers. It is reasonable to suppose that there was a decided saving in fuel effected under "A" and "C" over "B," as a clean boiler will certainly evaporate more water per pound of fuel than one that is scaled.

From the above it is evident that, from the standpoint of economy, the best water that can be obtained for boiler-feed use is the cheapest, and if water supply "A" could have been obtained for the cost of pumping it would of course have been the cheapest and best; but when the cost of city water is taken into consideration, then of the two raw supplies "B" is somewhat the cheaper. The best supply by far, from the standpoint of economy, is the well water using the softening system, "C."

A.

500 horse-power boilers evaporating 33⅓ pounds, or 4 gallons of water per horse-power per hour, 2,000 gallons per hour, 24 hours per day, 300 days per year, = 14,400,000 gallons at 8 cents per 1,000 gallons	$1,152.00
Washing out each boiler once every six months, 8 washings a year, requiring 1 man 1 day at each washing, at $1.50 per day	12.00
Heating to steam boilers cooled for cleaning, 8 boilers 125 horse-power each, requiring 1 ton of coal per 100 horse-power (estimated), = 10 tons of coal at $1.90 per ton	19.00
	$1,183.00

B.

500 horse-power boilers evaporating 33⅓ lbs. or 4 gallons of water per horse-power per hour, 2,000 gallons per hour, 24 hours per day, 300 days per year, = 14,400,000 gallons, pumping at ¾ cent per 1,000 gallons (estimated)	$108.00
Cleaning each boiler once every two weeks, 104 cleanings, 1 man 2 days per cleaning, 208 days' labor at $1.50 per day	312.00
Heating to steam boilers cooled for cleaning, 104 boilers 125 horse-power each, requiring 1 ton of coal per 100 horse-power (estimated) = 130 tons of coal at $1.90 per ton	247.00
Cleaning open heater once each month, 12 cleanings a year, 1 day for each cleaning, at $1.50 per day	18.00
Boiler compounds, 4,800 lbs. at 6 cents per lb	288.00
Boiler repairs	121.70
	$1,094.70

C.

500 horse-power boilers evaporating 33⅓ pounds or 4 gallons of water per horse-power per hour, 2,000 gallons per hour, 24 hours per day, 300 days per year, = 14,400,000 gallons, pumping at ¾ cent per 1,000 gallons (estimated)	$108.00
Softening 14,400,000 gallons of water per year, at 1½ cents per 1,000 gallons	216.00
Washing out each boiler once every 4 months, 12 washings a year, requiring 1 man 1 day at each washing, at $1.50 per day	18.00
Heating to steam boilers cooled for cleaning, 12 boilers 125 horse-power each, requiring 1 ton of coal per 100 horse-power (estimated) = 15 tons of coal at $1.90 per ton	28.50
Depreciation at 10 per cent on investment of $2,000 for water-softening system	200.00
Interest at 6 per cent on investment of $2,000 for water-softening system	120.00
	$690.50

The following table taken from the records of a small electric light plant operating a 175 horse-power water-tube boiler, shows the saving in fuel that can be effected by supplying boilers with clear water free from scale-forming substances. The load at which the boiler is operated is practically constant, varying only with the length of the day or the necessity for light on dark days. The figures cited are taken from a daily record of every pound of coal burned and cover a period of five months from January 1, 1905 to May 31, 1905 (the

boiler was cleaned every two weeks and compound was used), also from January 1, 1906 to May 31, 1906, with a water-softening plant.

COAL CONSUMPTION.

Without Water-Softening Plant.		With Water-Softening Plant.		SAVING.
Jan. 1905	307,070 lb.	Jan. 1906	248,430 lb.	58,640 lb.
Feb. 1905	280,455 "	Feb. 1906	221,470 "	58,985 "
Mar. 1905	300,352 "	Mar. 1906	241,380 "	58,972 "
Apr. 1905	286,307 "	Apr. 1906	210,600 "	75,707 "
May 1905	281,748 "	May 1906	212,860 "	68,888 "

Analyses of the water before and after treatment at this particular plant are as follows:—

WELL WATER.

Raw.	Grs. per U. S. Gallon.	Treated.	Grs. per U. S. Gallon.
Volatile and Organic Matter.	3.60	Volatile and Organic Matter.	.40
Silica	.30	Silica	.17
Oxides of Iron and Alumina.	trace	Oxides of Iron and Alumina.	trace
Calcium Carbonate	11.84	Calcium Carbonate	1.45
Calcium Sulphate	8.43	Calcium Sulphate	.15
Magnesium Carbonate	5.25	Magnesium Hydrate	.49
Magnesium Chloride	1.53	Sodium Sulphate	8.90
Magnesium Nitrate	4.73	Sodium Chloride	4.21
Sodium Chloride	2.37	Sodium Nitrate	5.34
TOTAL SOLIDS	38.05	TOTAL SOLIDS	21.11
Suspended Matter	.05		
Free Carbonic Acid	2.37		
Incrusting Substances	35.68	Incrusting Substances	2.66

The labor required for the operation of a water-softening plant need not be taken into consideration, because ninety per cent of the water softening plants in successful operation today are operated by the engine-room employee without interference with his regular work; and a wise engineer or boiler-room employee will give a water-softening plant proper attention to avoid the work of cleaning boilers, which at best is a disagreeable task.

A water-softening apparatus is a good investment for any steam plant wherever there is any trouble or expense in connection with the operation of the boiler due to scale or corrosion. The boiler is designed as a steam generator and not as a chemical retort for the formation of precipitates. Any work thrown on the boiler other than generating steam reduces its efficiency.

(To be continued.)

A DECADE OF AMERICAN RAILROAD HISTORY IN GRAPHIC FORM.

By Harold Vinton Coes.

IT is intended to set forth in this article, in graphic form, the various facts showing the growth of American railroads during the period from 1895 to 1905. To the average busy man tables and statistics mean but little; it takes too long and is too wearisome to get at the facts through them. But when the data are cast into graphic form, you have a picture readily appreciated by both eye and brain.

The total number of roads designated as operating roads on June 30, 1905, was 1,169. Of these 907 are independent so far as contractual relations are concerned.

Chart 1, Plate I, shows the increase in single-track, second-track, third-track, and fourth-track mileage, as well as in the total mileage. The total mileage in operation in 1895 was 233,000 miles; in 1905 it was 307,000 miles, an increase of 31¼ per cent. Chart 2 gives the density of mileage on different bases.* In 1895 the number of miles of line per 10,000 inhabitants was 26.0. This gradually decreased until in 1899 the minimum 25.3 was reached. The curve then rises, showing 26.4 in 1905. The number of miles of line per 100 square miles of territory, unlike the former curve, shows a yearly increase. This probably means that the population in certain sections of the country increased faster than railroad construction, for the latter curve shows an increase of 1.3 miles per 100 square miles per ten years, or 0.13 miles per 100 square miles per year. This last figure, therefore, can be used as a unit.

Charts 3 and 4, Plate II, pertain to railroad equipment. Chart 3 deals with cars only. The negative or decreasing direction of the curve marked "Fast Freight Service" can probably be explained by the fact that large corporations dealing in perishable goods had been gradually buying their own cars.†

The classification and sizes of both simple and compound locomotives are given in Table I. Locomotives have been classified according to White's System. (See footnote, page 804.)

* The bases are 82,494,575 population and 2,970,038 square miles area.

† NOTE.—The curves take no account of privately operated or privately owned cars.

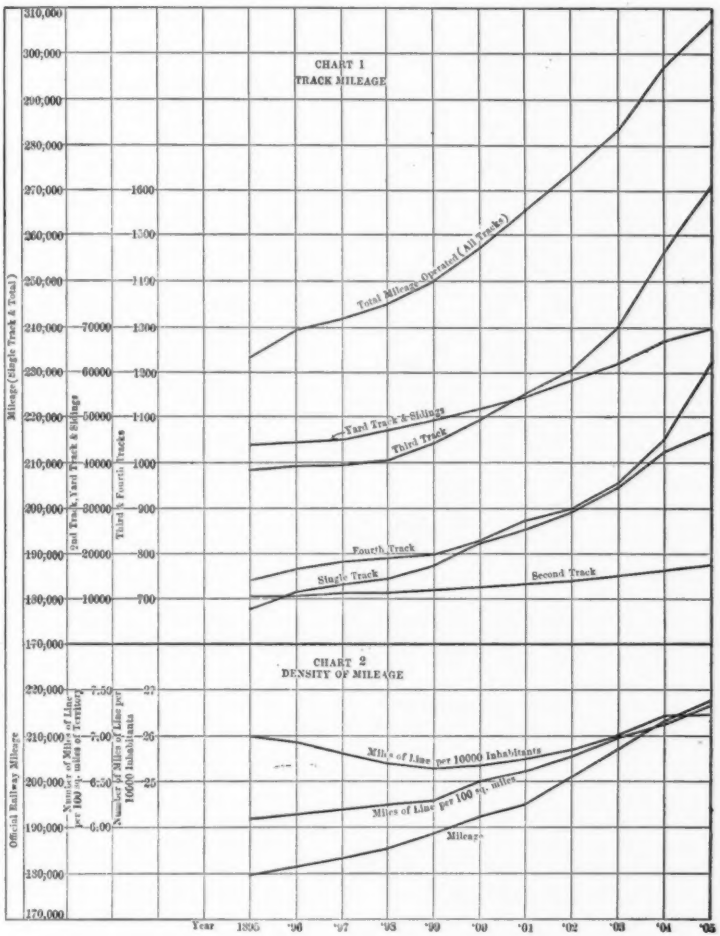


PLATE I. CHART I, TRACK MILEAGE. CHART 2, DENSITY OF MILEAGE.

A comparison of the earlier but incomplete records pertaining to locomotives with Chart 8, Plate IV, develops the fact that while American locomotives have been increasing in size at the rate of 2½ per cent a year, the size of the train to be handled has been increasing at the rate of 10 per cent a year.

A comparison of Table II (page 806) with figures for the previous

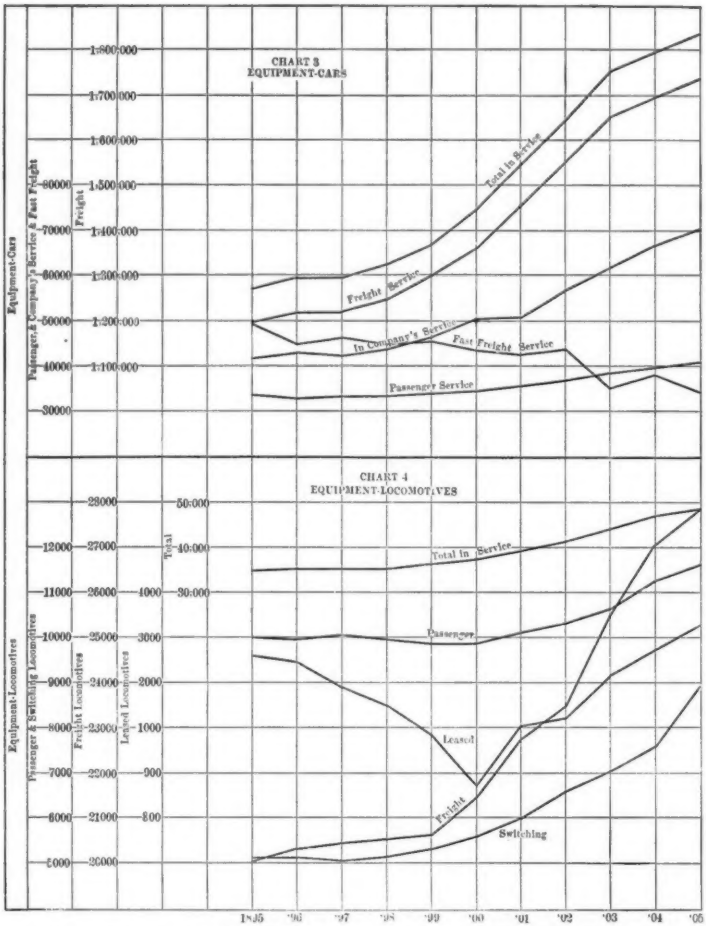


PLATE II. CHART 3, EQUIPMENT, CARS. CHART 4, EQUIPMENT, LOCOMOTIVES.

year discloses some significant facts. First, single-expansion locomotives increased in number from 43,246 to 45,033, or at the rate of 4.12 per cent, while compound locomotives decreased from 2,900 to

NOTE.—White's locomotive classification is based on the representation by numerals of the number and arrangement of the wheels, commencing at the front. Thus 260 means a Mogul and 460 a ten-wheel engine, the cipher denoting that no trailing truck is used. The total weight is expressed in 1,000 pounds. Thus an Atlantic locomotive weighing 176,000 pounds, would be classified as a 442-176 type. If the engine is compound the letter C is used; thus, 442C176. If tanks are used in place of a separate tender, the letter T is used similarly to the letter C.

TABLE I. DETAILED CLASSIFICATION OF LOCOMOTIVES.

1	2	3	4	5	6	7
				AVERAGE.		
Class.	Number.	Tractive Power.	Grate Surface.	Heating Surface.	Weight, exclusive of Tender.	Weight on Drivers.
		Pounds.	Sq. Ft.	Sq. Ft.	Tons.	Tons.
040—33	1117	14087	13	812	33	33
040 C_4 13	1	4900	7	450	13	13
060—53	5135	22650	23	1406	53	53
060 C_2 64	30	29972	28	1577	64	64
080—53	149	23530	31	1432	53	53
050—82	14	37132	41	2498	82	82
0660—167	1	70185	72	5600	167	167
240—24	42	10860	14	683	30	24
260—51	5188	22337	27	1609	60	51
260 C_2 61	136	25976	30	1838	71	61
260 C_4 70	158	28199	38	2347	82	70
280—69	11578	32906	42	2367	78	69
280 C_2 79	350	36718	43	2901	90	79
280 C_4 84	663	38133	51	2837	96	84
2100—87	10	39556	67	2948	98	87
2100 C_4 106	5	51502	61	4328	119	106
420—14	7	5427	12	510	24	14
440—31	10732	14591	21	1291	46	31
440 C_2 17	4	7843	14	635	26	17
440 C_4 38	17	12631	40	1534	59	38
460—50	8680	21912	28	1842	64	50
460 C_2 62	273	27029	35	2615	83	62
460 C_4 65	443	26622	40	2730	87	65
480—68	496	33064	42	2398	84	68
480 C_2 70	50	29942	37	2427	84	70
042—24	15	9939	11	595	29	24
042 C_4 37	1	12582	76	1429	70	37
062—55	13	20008	22	1549	66	55
222—6	2	1767	12	177	14	6
242—43	57	21369	56	2407	78	43
262—66	326	26976	46	2948	91	66
262 C_2 68	26	31550	49	3225	95	68
262 C_4 70	168	28889	52	3618	102	70
282—97	85	45098	57	3903	138	97
282 C_4 79	37	39060	45	3773	102	79
2102—112	1	61840	58	4796	138	112
2102 C_4 117	85	62729	58	4796	149	117
442—50	917	23231	50	2788	87	50
442 C_4 48	202	20598	46	2940	92	48
462—67	302	29539	47	3284	103	67
462 C_4 72	3	23418	49	3053	115	72
044—24	76	10196	14	660	31	24
044 C_2 20	1	8207	17	528	28	20
044 C_4 24	10	7709	18	502	36	24
244—29	44	12244	15	836	52	29
264—53	19	22748	45	1532	87	53
444—33	2	10710	18	1043	65	33
464—33	7	18743	21	1213	72	33
046—28	5	8396	15	707	50	28
246—36	10	16573	23	1251	83	36
266—53	3	19425	36	1843	64	53

C_2 = 2 Cylinder Compound.
C_4 = 4 " "

2,663, or at the rate of 8.9 per cent. Second, the comparison shows an increase in power and size of the average single-expansion locomotive. The average tractive power per locomotive of this class increased from 22,206 pounds to 23,178 pounds. The grate surface increased from an average of 29 square feet to 30 square feet, and the heating surface from 1,681 square feet to 1,759 square feet. The average weight, exclusive of tender, increased from 60 to 62 tons, and the average weight on drivers increased from 49 to 51 tons per locomotive.

TABLE II. CONDENSED CLASSIFICATION OF LOCOMOTIVES.*

	Single Expansion.		Four-cylinder Compound.		Two-cylinder Compound.	
Number	45033		1793		870	
Tractive Power—Pounds	23178	(Average)	32326	(Average)	31056	(Average)
Grate Surface—Sq. ft...	30	"	47	"	38	"
Heating Surface—Sq. ft.	1759	"	2941	"	2569	"
Weight, exclusive of Tender—Tons	62	"	95	"	83	"
Weight on Drivers—Tons.	51	"	73	"	69	"

Plate III shows the assignment of equipment per 1,000 miles of line, but as it is the passenger mileage and the freight mileage rather than the distribution that gives the true measure of equipment efficiency, we may pass on to Chart 8, Plate IV. The increase in passenger-miles per passenger locomotive for the year 1905 over the year 1904 was 100,174, and the increase in ton-miles per freight locomotive was 233,854. The total increase for the ten years in passenger-mile per passenger locomotive was 829,591, or 82,959.1 passenger-miles per passenger locomotive per year. The increase in ton-miles per freight locomotive was 2,431,879, or 243,187.9 ton-miles per freight locomotive per year. The curve marked "Freight Cars per 1,000,000 Tons of Freight Carried" shows a rapid decrease. This does not mean, as might appear at first sight, that freight traffic had fallen off, but is due rather to the increase in the use of cars of higher capacity. The increase in density of loading for both passenger and freight cars has consequently fallen off, due to the cause mentioned.

In the year 1905 one less passenger car was used per 1,000,000 passengers carried than was the case during the preceding year, and 79 fewer freight cars per 1,000,000 tons of freight carried. It is interesting to note that of the various products carried by the railroads—products of agriculture, products of animals, products of mines, products of forests, manufactures, merchandise, miscellaneous —50 per cent of the tonnage was made up by the products of mines.

* Excludes 661 unclassified locomotives.

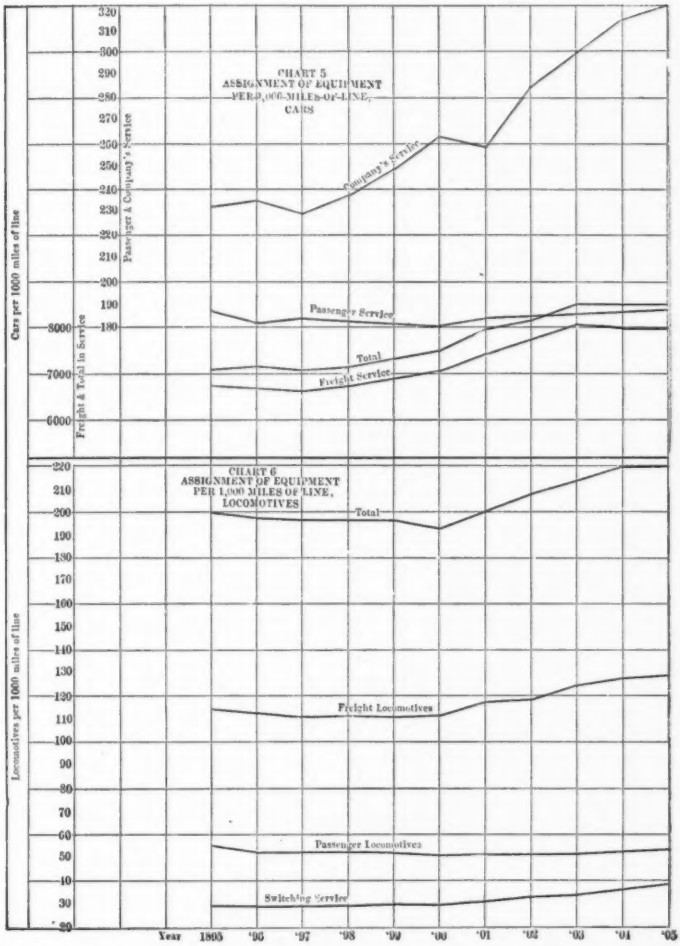


PLATE III. CHART 5, ASSIGNMENT OF CAR EQUIPMENT. CHART 6, ASSIGNMENT OF LOCOMOTIVE EQUIPMENT.

Chart 8, Plate IV, and Charts 9 and 10, Plate V, and the figures for 1905 derived therefrom indicate that railway transportation in the United States, despite criticism to the contrary, has attained a high degree of efficiency as compared with 1904 and the previous years. These curves show also a marked increase in the amount of business and density of traffic. The amount of passenger traffic during the

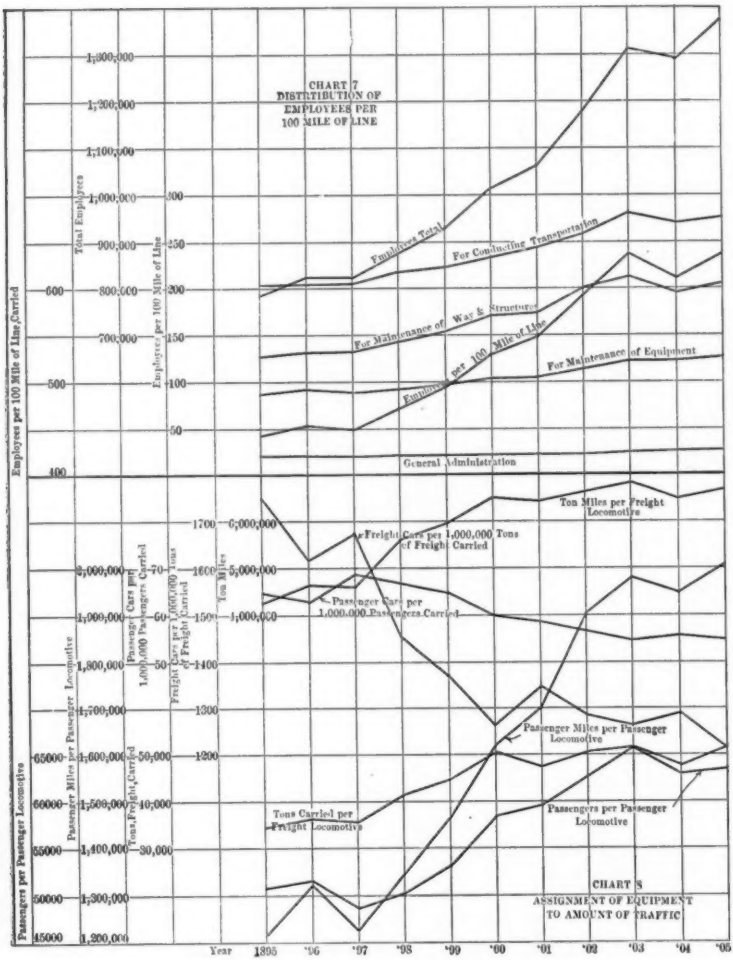


PLATE IV. CHART 7, DISTRIBUTION OF EMPLOYEES FOR 100 MILES OF LINE. CHART 8, ASSIGNMENT OF EQUIPMENT TO AMOUNT OF TRAFFIC.

year 1905 is especially noticeable. The number of passengers reported carried during this fiscal year (June 30, 1904 to June 30, 1905) was 738,800,000, an increase of 23,400,000 as compared with the previous year. The increase in density of traffic—that is, passenger-miles per miles of line—is also marked, this density having

increased from 104,200 passenger-miles per mile of line in 1904 to 109,900 in 1905. The increase in freight traffic, while not relatively so great, is nevertheless very noticeable. The ton-mileage accomplished during the fiscal year 1905 was 186,500,000,000, being an increase of 12,000,000,000 ton-miles. The density of freight traffic is shown by the fact that 861,000 ton-miles per mile of line were car-

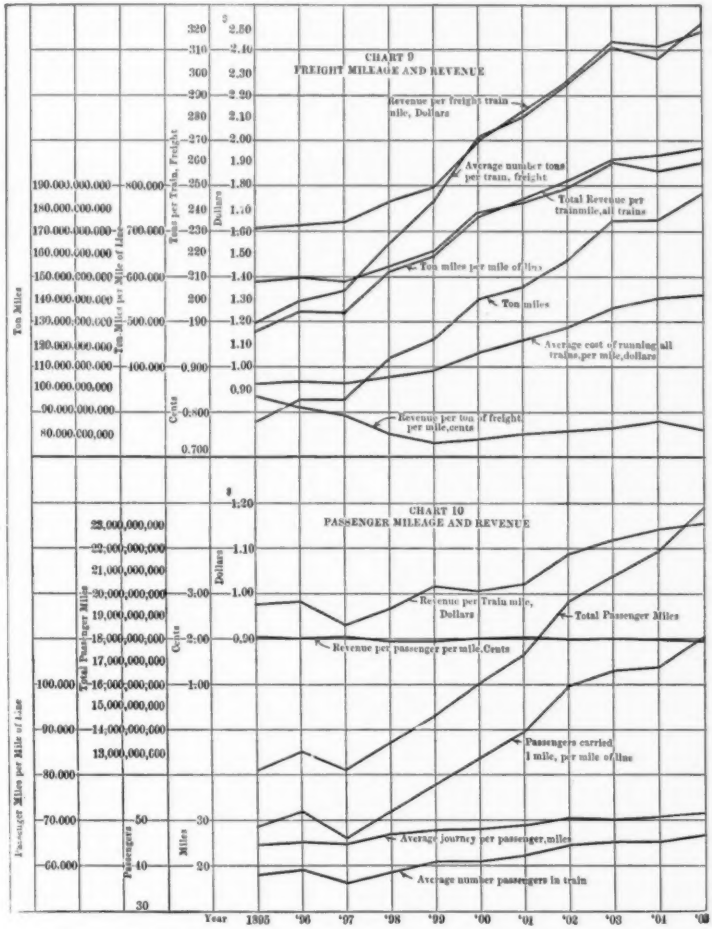


PLATE V. CHART 9, FREIGHT MILEAGE AND REVENUE. CHART 10, PASSENGER MILEAGE AND REVENUE.

ried. In this connection it may be interesting to note that the average haul in miles is less for the year 1905 than for 1904, the figure for 1905 being 237.56 miles against 244.30 miles for 1904. In 1899 (last authentic figure), it was 246.58 miles.

In Charts 9 and 10, Plate V, the cost of carrying freight and passengers is compared. The revenue per freight train-mile has increased

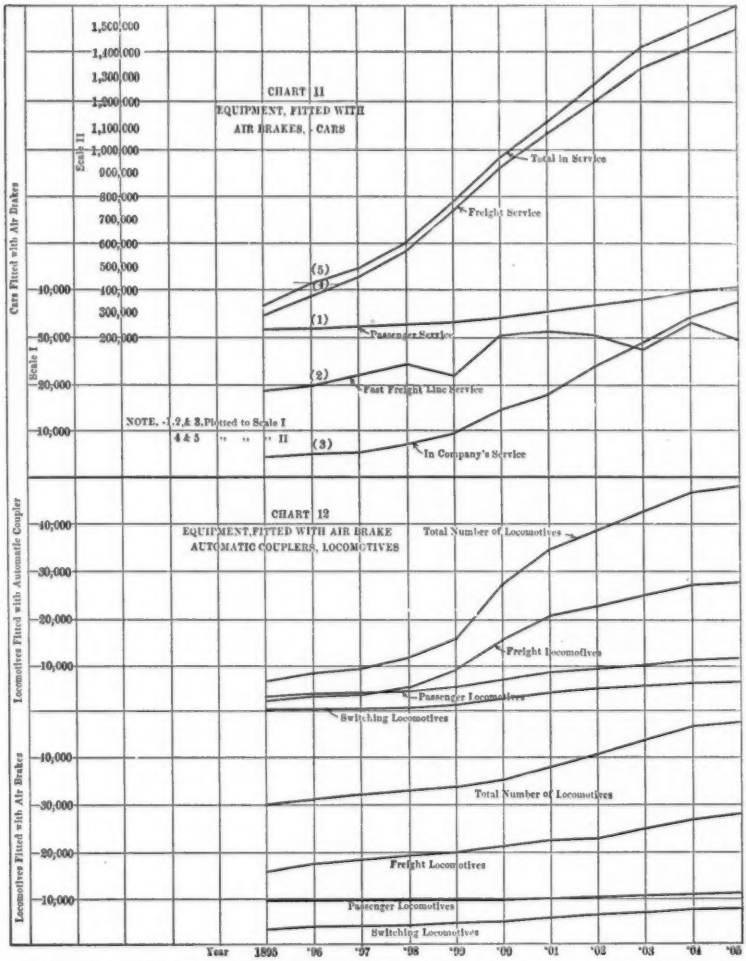


PLATE VI. CHART 11, AIR-BRAKE EQUIPMENT, CARS. CHART 12, DITTO, LOCOMOTIVES.

in the last ten years from $1.61 to $2.50 and from $.97 to $1.15 per passenger train-mile. The revenue per ton of freight per mile, as well as the revenue per passenger per mile, has decreased. Both of these curves are largely influenced by the policies of the various railroads, the action of the several State legislatures, and the attitude of the Federal Government. It is well to note that the average revenue per ton of freight per mile covers all kinds and classes of freight, and may be quite as much influenced by the change in the relative quantity of the different classes of freight as by a change in the rate itself.

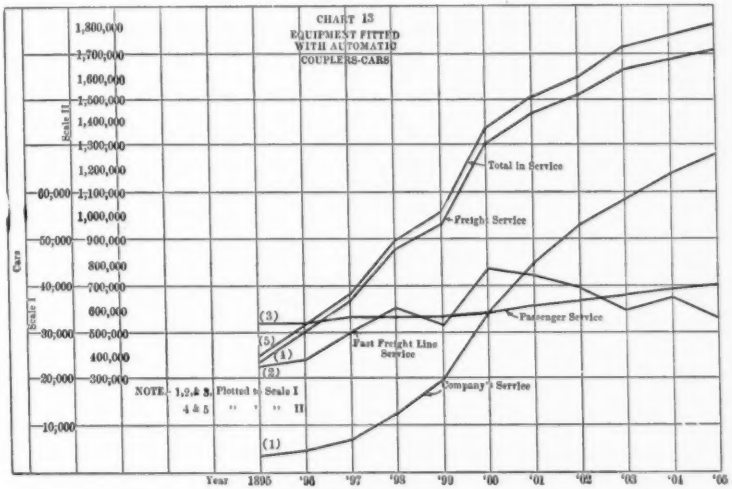


PLATE VII. CHART 13, AUTOMATIC COUPLER EQUIPMENT, CARS.

Plates VI and VII are self-explanatory and need no comment except to note that the increase in the use of the automatic coupler is paralleled by the use of the air brake.

In Plate VIII are differentiated the various items of expense on a percentage basis, to show by comparison where and what they are. It is well to state in regard to the relative percentages of operating expenses to operating income, that the changes in this ratio from year to year are largely influenced by the policy of the railroads in charging improvements to operating accounts. On June 30, 1905, the payrolls of the railroads showed 1,382,196 persons in railway employment earning $839,944,680. The operating expenses per annum at this time were $1,390,602,152, from which it appears that the

compensation paid to railway employees amounts to about 60 per cent of the total expense of operation.

Plate IX shows the Gross Earnings, Operating Expenses, Total Income, Income from Operation, Dividends, Net Income, and Surplus, all per mile of line operated, and the official mileage upon which the figures are based.

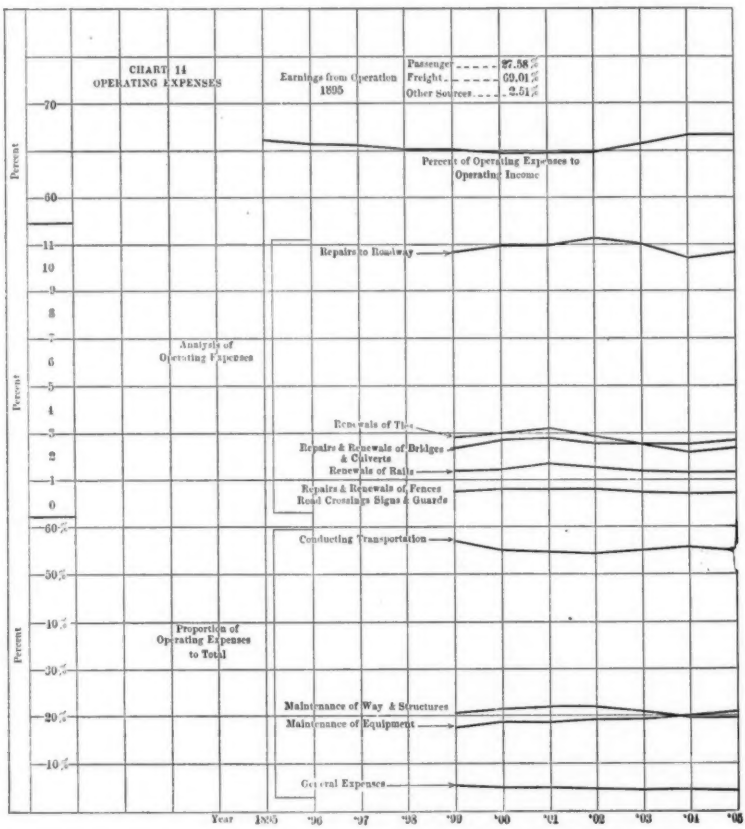


CHART 14
OPERATING EXPENSES
Earnings from Operation 1895
Passenger 27.58%
Freight 69.01%
Other Sources 2.51%
Percent of Operating Expenses to Operating Income
Repairs to Roadway
Analysis of Operating Expenses
Renewals of Ties
Repairs & Renewals of Bridges & Culverts
Renewals of Rails
Repairs & Renewals of Fences Road Crossings Signs & Guards
Conducting Transportation
Proportion of Operating Expenses to Total
Maintenance of Way & Structures
Maintenance of Equipment
General Expenses
Percent
Year 1895 '96 '97 '98 '99 '00 '01 '02 '03 '04 '05

PLATE VIII. CHART 14, OPERATING EXPENSES ON A PERCENTAGE BASIS.

The last set of curves on Chart 16, Plate X deal exclusively with the par value of railway securities. Railway stocks are classified as common and preferred, and the funded debt as bonds, miscellaneous obligations, income bonds, and equipment trust obligations. The

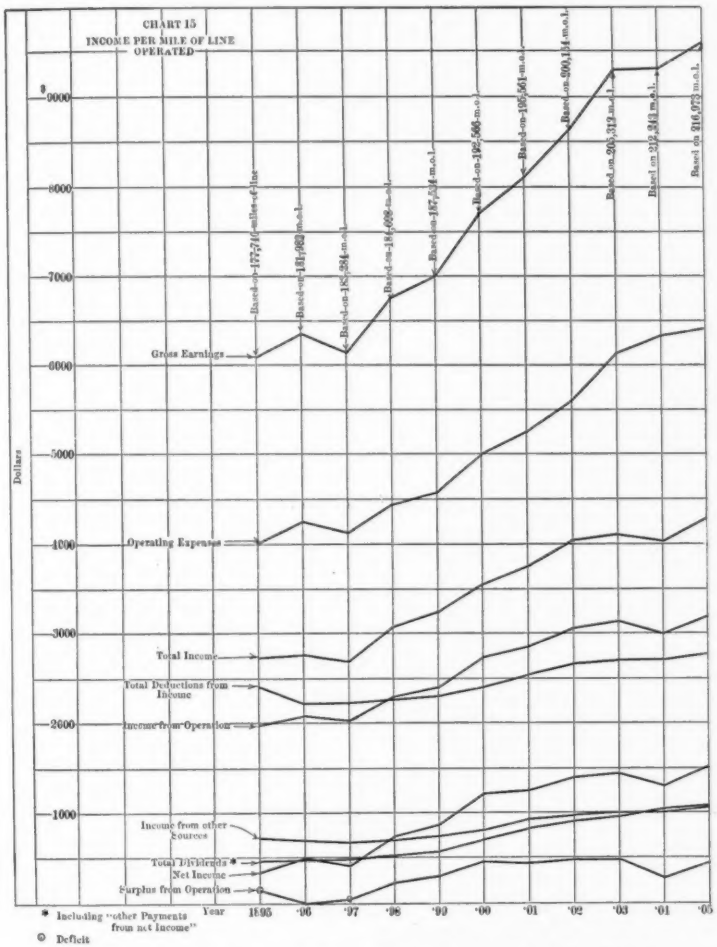


PLATE IX. CHART 15, EARNINGS, OPERATING EXPENSES AND INCOME.

aggregate of these securities makes up the total of the par value of railway capital. The most interesting curve of this set is the one marked "Per Cent of Stocks paying Dividends", which shows that only 29.9 per cent of the stocks paid dividends in the year 1895, while 62.8 per cent paid dividends in the year 1905; and this despite the periodic financial upheavals. It will be observed that the average

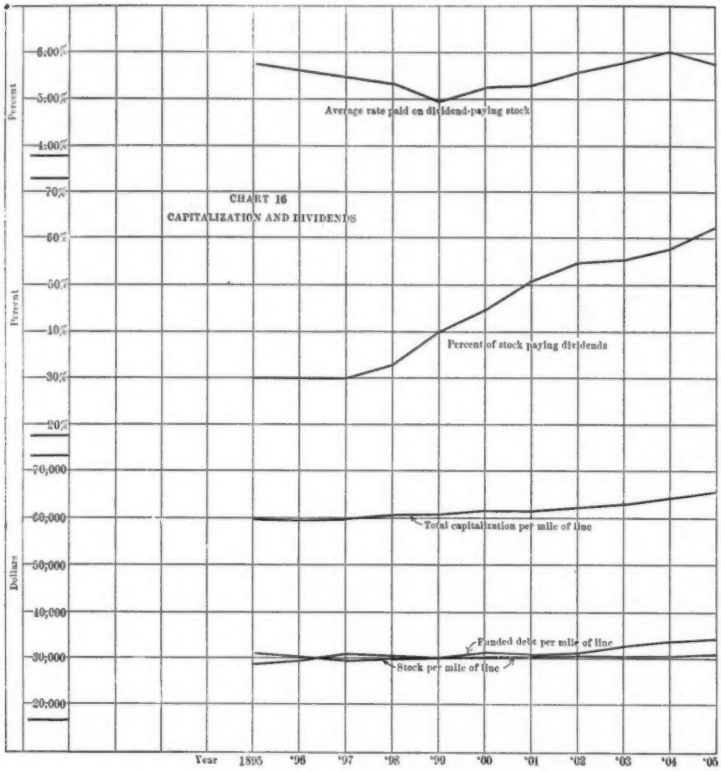


PLATE X. CHART 16, CAPITALIZATION AND DIVIDENDS.

rate paid on dividend-paying stocks during the year 1905 is 5.78 per cent, which is a slight decrease from the previous year (6.02 per cent). The explanation of this decrease may be found in the increase in the amount of stocks paying dividends (57.45 per cent in 1904 and 62.84 per cent in 1905). If so it does not indicate a reduction in the dividend-paying ability of the railroads, as might appear at first sight.

EDITORIAL COMMENT

The Panama Canal.

ACCORDING to Washington dispatches, Lieutenant-Colonel Goethals has stated to a Senate committee that he can not tell if the cost of the Panama Canal will reach $250,000, or $300,000, or $500,000; indeed, that he can not fix any estimate at all of the total cost. The admission is evidence of the colonel's frankness, and of course does not suggest the slightest disparagement to his ability. Accurate estimates are peculiarly difficult on the Isthmus. Uncertainties of geology, of climate, of labor, of appropriations, and of legislation operate cumulatively to disturb an exact solution of the problem.

The elements which make determination of costs finally impossible, however, are inherent in the system under which the chairman of the Commission must work. But try to conceive of the chief engineer for a great contractor making a similar admission of uncertainty!

Politics and Engineering.

A MORE sinister aspect of political interference with economical and orderly management of public work was displayed in the indecent attempt to discredit the Commissioners of the Board of Water Supply of New York in the matter of the Ashokan dam. Not only public interest but private reputation was contemptuously trampled in the attempt to seize, for political and personal profit, appointments which had been pledged to conscientious and impartial selection and which were filled with ability and honor. It has been pointed out by some of our contemporaries that the result of such attacks would be that service would become intolerable to men of high standing in their profession and in the community—that they would hold aloof from all public enterprises and leave them to the soiled hands of the political place hunters. Apparently this was exactly the result which the "investigation" sought to accomplish.

It failed completely, and recoiled upon the heads of its promoters, for two principal reasons. First, the strength of the position of the Commissioners, secure in absolute sincerity and single-minded loyalty to the interests committed to them; and second, the great wave of determined support which swelled up from the public press, technical and non-technical. The Corporation Counsel's advice to the Mayor is that which he might have taken from his own better judgment at the outset. He now has to drop a matter he should have never have taken up.

A Mistaken Public Enterprise.

IF the temper of retrenchment and economy should so far affect New York State as to lead to serious reconsideration of the barge-canal project, the gains of the present business disturbance would not be without their reward. Superintendent Stevens is far within the mark in saying that the project now under construction will be obsolete when it is completed. It is obsolete already. It is neither of the dimensions nor on the route of the waterway which would be really serviceable to transportation and commerce. The waste of money in pushing it so far is deplorable, but it would be better to charge that off as loss and save what is left of the original estimate than to sink more in the hope of making any practical success of the existing plans.

Train Ferry for the English Channel.

AMONG great engineering proposals which appeal to popular fancy for a sort of perennial vitality, the project for a tunnel under the English Channel has long been prominent. In its most recent revival, its advocates urged not merely the possible increase in the comfort, and therefore the volume, of passenger travel between England and the Continent, but the supposed great advantages to be secured by a through freight service, without transhipment at Channel ports. But if any such benefits as alleged would accrue to British trade by mere passage of "goods wagons" from British to Continental railway lines without breaking bulk, the ferry system would appear to afford all the necessary facilities with a fraction only of the uncertainty, cost, and inconvenience.

The transport of trains across the sea is no theoretical or untried proposal. Both on Lake Michigan and amongst the Danish Islands this method of transshipment has been in use for a considerable time. Nor is the mechanism of such transport either complex or expensive. Given a good harbor at either end and specially constructed vessels capable of taking made-up trains upon their decks, nothing more remains than to provide tidal platforms which enable the transfer to or from the boat to be made at any state of the tide. There is nothing particularly new nor particularly difficult in the provision of these tidal platforms. They may be seen in considerable number on the Mersey, where, it is true, only road vehicles are dealt with, and the enormous Prince's Landing Stage at Liverpool is a very fair example of a large floating structure of the kind which has worked for a great many years without the least trouble or difficulty.

To construct a tidal ferry in the Straits of Dover would not, as estimated, cost more than a twentieth of the capital outlay involved in piercing a tunnel. It would have many advantages. Under the stimulating effects of a large increase of traffic its facilities could be multiplied and extended quickly, cheaply and without any international complications whatever. It would avoid the menace—for a menace it seems to many British military strategists—of opening a possible line for sudden entrance by the forces of a Continental enemy. It would not weaken Britain's insular position, so strongly secured by the Channel fleet. No military problem is involved. The line of communication could be interrupted at a moment's notice by the smallest gunboat. It is not on the other hand a grandiose scheme, nor does it offer immense rewards to clever financiers, nor deeply stir the imagination like the great engineering feat of tunneling the ocean, but it is at least a practicable scheme. It secures the one thing worth securing, viz., greater advantages to commerce. It does this cheaply and therefore efficiently. More than this seems unnecessary.

Concerning Radio-active Medication.

THE efficacy of the "radio-energizing" of medicinal substances, mentioned in M. Boyer's article in our November issue, is doubtless believed in good faith by many persons; but the best authorities on the subject are at least sceptical, except possibly as to the cure of some forms of cancer. The emanation, even if therapeutically of benefit, dies away very quickly. To quote Mr. A. S. Eve, "in a month only a millionth of the activity remains, though polonium appears later." We must also correct a typographical error in the description of the mode of measuring radio-activity; the piezo-electric quartz is a plate, not a "sphere."

THE PREVENTION OF RAILWAY ACCIDENTS.

A PLEA FOR THE MORE GENERAL ADOPTION OF THE AUTOMATIC PRINCIPLE IN RAILWAY SIGNALLING AND TRAIN CONTROL.

The Engineer.

WHILE fatal railway accidents are much less frequent in Great Britain than in the United States, several collisions and derailments on British railways during the last few months, due to the breakdown of the "man" and not the "machine," have proved conclusively that there is urgent need for further protection of the lives of passengers than can be afforded by even the highest excellence of materials and construction in permanent way and rolling stock. With the report of nearly every accident it becomes more and more apparent that the neglect of duty on the part of the signalman or engine driver is the chief contributory cause of railway fatalities of these two classes. In extension of Mr. Coes' demonstration of this fact in connection with collisions on the railroads of the United States, presented in THE ENGINEERING MAGAZINE last month, the following forceful plea for the extension of the automatic principle in signalling and train control, taken from *The Engineer*, London, for November 22, 1907, is of great and timely interest.

"If we examine the early and middle history of accidents, we shall find that they were to a great extent the result of structural failures, such as broken axles, broken bridges, broken rails, and broken tires. There were serious collisions also; but few derailments. Speeds were comparatively speaking, low. The lines were not crowded. We do not hesitate to say that if machinery, workmanship, and materials had been as good thirty years ago as they are now, everything else remaining the same, accidents would scarcely have occurred at all. It is well to keep this constructive or structural excellence in view, or what follows will not be fully intelligible. Now, a reference to the reports of the Railway Department of the Board of Trade for the last few years will show that the main causes of deaths and disablement on our railways have been collisions and derailments; and again, if we search a little further, we shall find that in the majority of cases the derailments have been due to a neglect of signals—trains running at high speed round curves, when caution or stop signals were shown, and plain instructions were supplied to the drivers. Collisions have been brought about by defective signalling, or by want of understanding on the part of the driver or fireman, or guards of a train. In other words, it may be said that railway mechanism is no longer the cause of disaster. Accidents are the result of the breakdown of the man, not of the machine. Formerly the machinery was more stressed than the man. In the present day the position is reversed, the man is more stressed than the machine. The logical deduction is, that in the future the abolition of death on the railway is not to be sought in further improvements in material or workmanship, or design of permanent way or rolling stock, but in the relief of stress in the human machine. This desirable result cannot be obtained by

shortening hours. There is no reason to assume that under modern conditions 'brain fag'—to use a modern phrase which has no true physiological meaning—in so far as the time of service is concerned, has much to do with the matter. Signalmen have made mistakes after a couple of hours work. The only direction in which there is any promise of improvement—and by many that is still held to be problematical—lies in the extension of the automatic principle. Almost from the first automatic signals were suggested. More than half a century ago, in the Exhibition of 1851, there was shown a device by which a train passing a signal-post raised the arm to danger by running over a sort length of bar at the side of the rail. The arm was controlled by a clock in the signal-post, and would not fall for a period fixed according to the exigencies of traffic, but, generally speaking, of five minutes. There was, of course, no block system, but this invention served to maintain a time interval between two trains. From that date forth invention has followed invention; but the signalman still controls the traffic. The reason is simply that the man is held to be more trustworthy than automatic mechanism. There is, however, an apparent inconsistency. Although in certain respects, and within limits, implicit confidence is placed in him, he is not trusted with the control of signals connected with points. These are invariably interlocked, with the result that responsibility is transferred not to the mechanism, as would appear at first sight, but to the engine driver. A signalman cannot leave the siding points open and show main line clear for an express; but this does not eliminate all risks, because the driver may run through his signals and wreck his train. To secure absolute perfection the system should be such that the driver cannot, if he would, run through his signals.

"It is quite beyond our purpose to deal here with automatic mechanism. It is in use in train brakes; it controls signals from station to station, or cabin to cabin. In the present day of electrical development it is admitted generally that there is no physical reason why a driver should not have it forced upon his sight and dinned into his ears that he must stop. But there remains behind the certain faith—it is not knowledge—that automatic signalling is not nearly as trustworthy as human signalling. We are assured that automatic signals break down and cannot be trusted. If, however, we look below the surface, we shall find that this is in the main the result of expecting too much. The inventor provides all that he considers needful, and assures the head of the signal department that his mechanism is so complete in every detail that it will work for six months without attention. The superintendent, after making allowances for the utterances of a sanguine inventor, himself lays down an impossible standard of excellence. The thing is automatic. If it cannot be trusted without supervision, then it cannot be trusted at all. But he does not trust the existing automatic locking of points and signals. The telegraph instruments and live wires are kept under constant observation. In precisely the same way, or rather to a much greater extent, all the mechanism of automatic signalling should be kept under the most careful observation. Brains must be devoted to this work instead of to looking out for trains.

"It is not to be supposed that the signalman can be entirely dispensed with. At important stations he will always be needed. Without him it would be very difficult to retain the necessary flexibility in working the traffic. But even while retaining his services, the extension of the automatic system beyond its present limits could easily be employed as a check on the signalman, which would prevent him from making mistakes. To take a very common case. Collisions have frequently occurred simply because the signalman has forgotten that a train is standing on the line close to his cabin. Now there is, of course, no reason why a bell out of his reach and beyond his control, should not ring, say, every minute while the train remains still. Or, if an audible signal of the kind might be supposed to worry him and prevent him from attending to other trains, then a visual indicator might easily be provided. There are a dozen ways in which, having due regard for the influence of climate, the principle of making the train set its own signals may be used. But no real progress will be made in this direction so long

as those controlling the traffic hold to the theory that a man must be more trustworthy than, say, an electro-magnet. At one time this theory had, certainly, a strong basis of fact, the stronger that too much was expected from the mechanism employed. No doubt the man was then more trustworthy than the magnet. But this is no longer true. It may be now taken as proved that the utmost has been got out of the man. Nothing now remains but to supplement him. Even the most sceptical will, we venture to think, admit that, given efficient supervision, an automatic system will avoid the blunders and mistakes and errors of judgment which have of late years been mainly responsible for collisions and derailments on the railways of this country. The United States supply a valuable object lesson. The last Report of the Inter-States Commission tells the world that, in round numbers, 5,000 persons lost their lives on American railways last year. After deducting all other causes of death, we have a fearful list of derailments caused by bad permanent way, and of collisions due to the failure of drivers and signalmen to do their duty. We have, in short, a combination of ancient conditions of bad materials and crude construction, and modern conditions of heavy traffic. The first we have in this country eliminated, the latter remains. Who can doubt that the extended adoption of the automatic system would be productive of good in the United States? It has formed no part of our purpose to name any particular invention, or to show how, had it been installed, a particular railway accident could not have taken place. Various discussions—notably at the recent Conference of the Institution of Civil Engineers—prove that automatic signalling is quite compatible with the highest standard of safety. It remains to be seen if any argument based on modern information can be urged against it in principle. Let it once be conceded that it may be more trustworthy than the man, and its adoption with all the resultant benefits will follow in good time."

THE COMMERCIAL ASPECT OF ALPINE RAILWAY TUNNELS.

A REVIEW OF PAST AND PRESENT PROJECTS FOR THE IMPROVEMENT OF OVERLAND COMMUNICATION BETWEEN NORTHERN AND SOUTHERN EUROPE.

Engineering News.

IN connection with a description of the Lötschberg tunnel between Brieg and Frutigen in Switzerland, *Engineering News* for December 5, 1907, published a long editorial on the commercial aspects of present and proposed Alpine railway tunnels, of great interest in making clear the importance and exact status of these projects which of recent years have become so numerous and perplexingly complicated. In the following extracts the main features of this extensive discussion are given.

"In the first place it should be explained that there is a great 'trade route' running southeast across Europe from the west coast to the Mediterranean, and this is obstructed by the mountain ranges of the Alps, extending northward between France and Italy, and eastward between Switzerland and Italy; further eastward, where it separates Italy from Austria, the barrier is less serious. The most formidable part of the range lies across the 'trade route' above mentioned. The development of the existing and proposed routes across the Alps has been undertaken to provide improved facilities for existing traffic, rather than to develop new traffic. It has been governed largely by national commercial rivalry, and to an important extent also by municipal rivalry (especially as regards the Italian connections), and by railway rivalry in France. It has also been governed by two traffic conditions: (1) The freight traffic between northern European ports and industrial centers and the Mediterranean ports. (2) The passenger traffic, including the great tourist traffic to Italy and also that of what is known as the 'overland route' to India and the East. For many years the steamships on the oriental routes have made Brindisi (in Italy), near the southern end of the Adriatic Sea, a port of call for passengers and mails. Here the outbound steamers from England, after passing around France and Spain and down

the Mediterranean, receive passengers and mail leaving London some days later than the steamers. In the same way, the homeward bound steamers land passengers and mails for British and continental cities, which are thus saved considerable time as compared with the longer and slower route by sea. Thus, very costly works may be warranted by a resultant saving of a few hours in time of transit.

"The trade and travel between Italy and its ports and Switzerland and northern Europe was, up to 1870, carried by the three great mountain highways crossing the Alps at the Simplon Pass (built by Napoleon in 1806), the Splügen Pass (1822), and the St. Gothard Pass (1824). In 1867, the Brenner Ry. (with an open summit in the Brenner Pass, in Austria) was opened, connecting the Austrian railways with those of Italy. At about the same time the Mt. Cenis railway was opened, crossing the Alps by a switchback line having steep grades, operated by the Fell grip-rail system. The traffic capacity of this was limited, but four years later, in 1871, the Mt. Cenis tunnel was opened, giving a direct line westward into France. It became evident that these new trade routes would absorb so large a proportion of the business that in order to regain a due share of this business and to protect Italian and Swiss interests it would be necessary to build a railway to connect Italy with the countries lying north of the Alps. The three highway routes were all examined with a view to the possibility of railways on approximately the same lines. The Simplon was rejected as being tributary to the interests of France rather than of Switzerland and Germany. The Splügen was rejected on military grounds, as being too near the Austrian frontier, and liable to seizure in case of war. The St. Gothard route was adopted, and in 1869 a treaty providing for the construction of the railway was made between Italy and Switzerland. In 1871, Germany also became a party to the treaty. The great summit tunnel was commenced in 1872 and completed in 1881. While this tunnel is the special engineering feature, it should be understood that the St. Gothard Ry. involved the construction of some 53 tunnels, aggregating about 25 miles in length.

"The Arlberg tunnel, on a railway connecting Austria-Hungary with Switzerland and western Europe, was completed in 1883. This line was 80 miles long, from Innsbruck to Bludentz, and had maximum grades of 2.5 per cent. South from Innsbruck runs the line to the Brenner Pass, already mentioned."

As an offset to the loss of traffic to the French railways by the opening of the St. Gothard line, the Simplon tunnel between Italy and Switzerland was proposed as early as 1870, but for various reasons the actual beginning of construction was delayed until 1895. The object of this tunnel was to give France communication with Italy by a shorter and easier route than that offered by either the Mt. Cenis or St. Gothard lines. Both these objects have been attained, the Simplon giving a route from Paris to Milan 55 miles shorter than the St. Gothard and 59 miles shorter than the Mt. Cenis, but this by no means put an end to projects for other lines. What the French railways are striving after is a direct route into Italy equally favorable with that of Germany and northern Europe. At present the only direct connections are by the Mt. Cenis tunnel and a coast line from Marseilles to Genoa, but this route is too long to enter into competition for international traffic.

The project now receiving the greatest attention for this purpose is that for the Mt. Blanc tunnel which has been proposed ever since 1836. The route now advocated is essentially the same as that proposed in 1878 from Chamounix to Courmayeur connecting with the Italian railways at Aosta. This route would shorten the line from Paris to Genoa over the Mt. Cenis by 52 miles, over the Simplon by 57 miles, and over the St. Gothard by 110 miles. It would have the disadvantage of high elevation and heavy grades and considerable auxiliary construction would be necessary before the line could be really competitive, but these considerations do not seem to carry much weight with the French promoters who are anxious for a direct mountain crossing at any cost.

As an alternative to the Mt. Blanc route, another route is proposed under the little St. Bernard, while Italian promoters advocate a line through the Great St. Ber-

nard into Switzerland as a rival to both these routes. Other tunnel projects as auxiliary to the lines already in service are also very numerous, the most important being the Splügen Pass, the Lötschberg, now actually under construction, and the Faucille in France. The Lötschberg tunnel is to give Germany a direct connection with the Simplon line, while the Faucille project is generally regarded as a preliminary to the Mt. Blanc route. The smaller projects for the improvement of approaches to one or other of the mountain tunnels are too numerous for description.

"It has been suggested that the enormous cost of these great mountain tunnels might have been avoided, or postponed, by the construction of steep-grade switchback lines through the passes, as has been done in several cases in this country. There were two great objections to such a method, however: (1) the deep snows and heavy storms of the upper Alps; (2) (but most important) the necessity for speed and traffic capacity on railways competing for the business which already existed on a great 'trade route' and which would increase with better facilities for transportation. As a matter of fact, however, the first railway to cross the Alps was an open line, following closely the route of the highway or post road over the Mt. Cenis. This was operated by the Fell grip-rail system, in which pairs of horizontal driving wheels on the engines were powerfully gripped against a double-headed rail laid on its side on supports between the running rails. This line was opened some years before the completion of the tunnel, but was abandoned.

"With all subsequent projects, however, the problem has been much more difficult than that of simply getting a line across the mountains which has been the problem in the construction of railways across the Rocky Mountains. The Alpine tunnels are incidental parts of great traffic routes, and with each new project it has been necessary to locate a line which would be superior to preceding lines in regard to distance, time and operating conditions. Thus, with tunnel routes existing by the Mt. Cenis and St. Gothard routes, it would have been waste of time to even consider a steep-grade switchback line for the rival Simplon route. The actual length of tunnel was a secondary consideration. What was needed was a line that would attract traffic by its more favorable conditions. It may be noted, for example, that the through traffic of the Simplon tunnel was estimated at 140,000 tons per year, of which 70 per cent. would be taken from the St. Gothard and 30 per cent. from the Mt. Cenis routes. The same principles and conditions govern the selection of the later routes now being proposed. It may be noted, however, that an open-air line operated on the Fell system has recently been proposed, on a route from Oulx, on the Italian side of the Mt. Cenis railway to Briancon, in France. This, however, is not on the main traffic route to the northwest, but is for an improved connection between the south of France and the great industrial centers of Turin and northern Italy. It would shorten the distance between Turin and Marseilles by 62 miles as compared with the present route by Genoa and Ventimiglia. The line would be 24 miles long and would cost $3,000,000.

"Summarizing the above review of Alpine tunnels and tunnel projects, it may be said that while some years of discussion and preliminaries must necessarily pass before any new Alpine line is definitely adopted and commenced, the indications are that the next international Alpine railway enterprise to be carried into effect will be that for a direct route between Italy and France (crossing only a small corner of Switzerland), as an offset to the Simplon route. It is significant to note again in this connection that the former routes have been built successively in rivalry of their predecessors and for competitive purposes. When the Mt. Cenis tunnel had connected France and Italy, the St. Gothard was planned to give Switzerland and Germany similar (but even more favorable) communication. This in turn was followed by the Simplon tunnel in the interests of France. Hardly had this been completed when work was started on the Lötschberg tunnel to give Germany a connection with the Simplon. And at the present time the greatest activity centers about a more direct French-Italian route in order to restore to France the possession of a route superior to all its predecessors."

ELECTRICAL ENGINEERING EDUCATION

A DISCUSSION OF THE TEACHING AND CURRICULUM BEST SUITED TO THE EDUCATION OF THE ELECTRICAL ENGINEER.

Chas. F. Scott, Chas. P. Steinmetz—American Institute of Electrical Engineers.

THE great interest in electrical engineering education manifested by the attendants at the last annual convention of the American Institute of Electrical Engineers resulted in November, 1907, in the appointment of a committee to organize the work of promoting discussion on this important subject. On January 24 a special meeting was held at New York under the auspices of this committee, and judging from the interest and breadth of the discussion, the work of the committee is likely to be productive of much good. At this meeting, as an introduction to the discussion, a digest of all the papers on the subject presented before the Institute since 1892 was introduced by Mr. Chas. F. Scott and this was followed by a paper by Dr. Chas. P. Steinmetz, both of which are reviewed below.

Mr. Scott's short introductory paper emphasized the general agreement as to the importance of the subject, but pointed out that while the technical schools are willing and anxious so to shape their courses as to produce the type of engineer best suited to the demands of industry, there is no general agreement as to what is really desirable in the young graduate. Some demand skilled artisans and some trained engineers. Some expect technical specialists and some men of all-round knowledge and capabilities. In some cases the young graduate is expected to be immediately productive, while a number of the larger manufacturers provide practical courses of training. Mr. Scott believes that the best engineering education is that which fits the individual student for his largest development and usefulness *in the long run* and that eventually this sort of training will be accepted as the solution of the present much debated problems. In the meantime, however, the discussion centres around the following points, on which widely divergent opinions have been expressed in papers previously presented before the Institute, a digest of which follows Mr. Scott's paper:

"1. The desirable characteristics of the acceptable graduate with respect to:

a. Practical familiarity with electrical apparatus which will enable him to be immediately useful, versus a less practical and more general training, which is to be supplemented by an apprenticeship course or its equivalent.

b. Specialized technical training and technical knowledge, versus a broader education aimed to develop intellectual power rather than the acquisition of technical knowledge.

"2. The arrangement of subjects and courses which will best produce the desired results. The following questions arise:

a. The relative attention to be given to the practical or industrial, the scientific, and the cultural.

b. The relative proportion between subjects which are valuable for imparting technical knowledge and those affording training in scientific and logical methods.

c. The relation between school instruction and practical work; whether one should precede the other, and if so which one should come first, or whether they should alternate once a day, once a year, or at some other rate.

d. The importance of current engineering practice; of lectures by practising engineers; of discussion of current topics in local meetings of the Institute.

e. The degree of desirable differentiation in courses or methods on account of differences in the characteristics of individual students or in the fields of work they expect to enter.

f. The sequence of subjects—whether the theoretical ground-work should be laid during the first few years and the practical subjects reserved until the latter part of the course, or whether an intermingling of the two in accordance with the concentric method outlined by Professor Karapetoff is to be preferred."

Dr. Steinmetz's paper was in thorough agreement with Mr. Scott's view that

training in the fundamental principles rather than education in a mass of memorized facts is the only satisfactory solution of present difficulties. The conditions for good electrical engineering education are more favorable in the United States than anywhere else. The great magnitude of the development of the electrical engineering industries, the general demand for technically trained men, the close co-operation between the industrial and educational branches of the profession are all circumstances favoring excellence in the results of technical instruction. There are, however, glaring defects in methods which prevent the attainment of the success in technical education which should be secured by the ample means at the disposal of most technical schools.

"The great defect of the engineering college is the insufficient remuneration of the teaching staff: the salaries paid are far below those which the same class of men command in industrial work, and as a result the college cannot compete with the industry for its men, but most of the very best men are out of reach for the colleges. The teaching forces of the colleges, therefore, consist of: 1. A few of the very best men, who are specially interested in educational work to such an extent that they are willing to sacrifice financial returns for it. These men have made the engineering college what it is; but even many of these men are ultimately forced by considerations of family, etc., to leave college work and enter industrial employment. 2. Many younger men interested in teaching, enter college work to give it a trial. Some of these remain, but many return to industrial work, when they are forced to realize the small prospect of financial return offered by the college. 3. First-class men who devote a part of their time to the college and a part to industrial work, usually consulting engineering. This arrangement is probably the best for the college, handicapped as it is by the policy of salaries which may have appeared sufficient in branches in which no industry competes, but which are suicidal in the engineering department. Still it would be far preferable if the colleges could get the benefit of the whole time and the undivided interest of these men." A vast improvement could be made if a large part of the sums now expended on magnificent buildings and extensive laboratory equipment were used in procuring the highest grade of men as teachers.

Grave objections may also be made to the curricula and methods of teaching of the engineering schools in that quantity seems to be sought before quality. Students are forced to memorize for examination purposes a vast amount of detail more than they can possibly digest.

"It stands to reason that with the limited time at his disposal, it is inadvisable for a student to waste time on anything which he forgets in a year or two; only that which is necessary to know should be taught, and then it should be taught so that at least the better student understands it so thoroughly as never to forget it. That is to say, far better results would be obtained if half or more of the mass of details which the college now attempts to teach, were dropped; if there were taught only the most important subjects—the fundamental principles and their applications—in short, all that is vitally necessary to an intelligent understanding of engineering, but this taught thoroughly, so as not to be forgotten. This, however, requires a far higher grade of teachers than are needed if the mere memorizing of text-book matters, reciting them, at the end of the term passing an examination on the subject and then dropping it. The salaries offered by the colleges are not such as to attract such men. When the student enters college he is not receptive to an intelligent understanding, for after a four years' dose in the high school of the same vicious method of memorizing a large mass of half and even less understood matters, the student finds it far easier to memorize the contents of his text-books than to use his intelligence to understand the subject-matter. After graduation, years of practice do for the better class of students what the college should have done—teach them to understand things. It is, however, significant that even now young graduates of foreign universities, in spite of the inferior facilities afforded abroad, do some of the most important electrical development work of this country. Men who never had a college education rise ahead of college

graduates. This would be impossible if our college training gave what it should, an intelligent understanding of electrical engineering subjects."

Dr. Steinmetz mades a strong plea for the general education of the electrical engineer. The development of the electrical industry is so rapid that the graduate of the school which has dropped from its curriculum everything not required in electrical engineering soon finds himself out of the race for success when subjects become of importance which were not considered as part of the trade of electrical engineering at the time when he received his education. Such an one is utterly helpless when any occasion arises which requires general knowledge outside of his trade as he learned it. In a good many technical schools this fact is recognized and an attempt is made to teach or review general subjects, both cultural and technical. Such attempts, however, usually fail to be of any real service owing to the brevity of the courses or wrong methods of teaching. In the same way instruction in chemistry, civil engineering, etc., is often of little real service, being totally unsuited to the requirements of the electrical engineer. Dr. Steinmetz believes that an important factor in the inferiority of the product of American technical schools to that of those abroad is due in large measure to the inferior teaching of the sciences allied to electrical engineering.

"In conclusion," he says, "the main defects in the present electrical engineering training in some of our colleges appear to me as follows:

1. The insufficient remuneration of the teachers, which makes most of the best men unavailable for educational purposes and is, therefore, largely responsible for the other defects.

2. The competition between colleges, which leads to a curriculum marked more by the quantity of the subjects taught than by the thoroughness of the teaching. The graduates are sent out with a mass of half understood and undigested subjects, quickly forgotten, and deficient in understanding of the fundamental principles and in the ability to think.

3. The tendency of some colleges to teach the trade of electrical engineering rather than educate intelligent and resourceful electrical engineers.

4. The unsatisfactory state of the teaching of allied sciences, which gives instead of general view and understanding of the science, a fragmentary knowledge of some details."

THE ECONOMIC MANAGEMENT OF STEAM PLANTS.

A SUMMARY OF THE FACTORS INFLUENCING THE EFFICIENCY AND ECONOMY OF OPERATION OF STEAM PLANTS.

William H. Patchell—Association of Engineers-in-Charge.

THERE are few problems in modern industry of more importance than that of the economical production of power. Economy and efficiency in power production is especially important in steam plants on account of the steady rise in the price of coal, and the factors entering into the securing of these conditions are of the utmost interest to the engineer. An interesting summary of some of the more important means of securing economical operation is given in the recent presidential address of Mr. William H. Patchell before the Association of Engineers-in-Charge, of which the following is a brief abstract.

Dealing first with boiler feed water, Mr. Patchell believes that in a great many cases it is more economical to take water from a well on the premises than from city mains. The bored well has proved its reliability and by the use of geared pumps or, preferably, when the water supply is plentiful, the air lift system a low priced and very efficient water supply system can be obtained. Of course in making the change from a supply from mains to a supply from a well the quality of the water must be considered carefully, for it is never economical to feed impure water into the boiler. If the water has scale-forming propensities the loss in heat is very serious, while if it forms only sludge a great amount of time is consumed in

blowing off. Feed water should always be purified as much as possible and the open heater is one of the simplest and most efficient types of purifying apparatus.

The rising price of coal makes the problem of securing the most efficient combustion possible one of the utmost importance. In many cases economy will lie in the burning of smaller and cheaper grades, not only in connection with mechanical stokers but also with hand firing. In burning small sizes the stoker must be made to keep his fires thin to permit of an ample circulation of air through the bed of fuel. Steam jets under the grate form a simple means of assisting the draught, but unless carefully watched the amount of steam blown away assumes most uneconomical dimensions. It is much better to use a fan whenever possible. Forced draught requires a smaller fan, but the induced draught system has certain advantages when the chimney draught has to be assisted only on peak loads.

"Gas analysis has of late years received attention, though for many years it was ignored alike by experts when testing steam boilers and by the users of boilers; it is only of late years that the percentage of CO_2 in the flue gases has been recorded on boiler tests. Thousands of tons of coal are wasted yearly by the neglect of the subject. The average amount of CO_2 in the gases may be taken at about seven per cent, which means a loss of twenty-six per cent. in the calorific value of the fuel. Greater care would increase the percentage of CO_2 to, say, twelve per cent, which means a loss of fifteen per cent only, and would represent a saving of ten per cent, which would quickly pay for the apparatus involved. The benefit of recording the CO_2 in the flue gases was first realized in Germany, whence the earlier types of instruments were developed. Since their introduction into England many of the faults in the earlier types have been eliminated, and some of those now on the market merit a much larger recognition than has yet been accorded to them. In many German works it has long been the custom to pay the stokers a premium on the amount of CO_2 recorded, with beneficial results.

"Purchase of fuel by analysis is very important, but when we consider the ease with which coal merchants can sell their stock, it is not surprising that they do not generally view the system with favor, and resent the incorporation of such clauses in their contracts. More united effort will be needed to get them educated up to this equitable method of buying fuel. Experience gained by several years' trial has proved to me that sampling and analysis may be done quite commercially under a contract which states the amount of volatile hydrocarbons and ash allowable, with a penalty if the amount of ash is exceeded."

In selecting mechnical stokers care must be taken to choose a type which will burn different classes and sizes of fuel, and it must also be remembered that stokers which give excellent service under a certain type of boiler may be useless under others. Where only one or two boilers are in use no saving in labor can be made by installation of mechanical stokers and the saving effected in the class of fuel used must be very definite to warrant the additional capital outlay.

"Steam superheating, although increasing rapidly in favor, is still conspicuous by its absence in many plants where it could very readily be adopted with a distinct gain in economy. No matter whether the steam is to be used in an engine or for heating purposes, the gain due to superheating is very marked. The ill effect of condensation in steam pipes is cumulative, and the application of steam traps to remove the water offers a fine field for further waste. Pipe covering is frequently only literally applied, all the flanges being left bare. Although gills and flanges are recognized as necessary adjuncts on radiator pipes, it is strange that when an attempt is made to prevent radiation from steam pipes, these are the very parts which are usually left bare. The excuse is sometimes offered that leakage and the necessity for attention to joints prevent the adoption of covers to flanges. If the joints are properly made and the flanges stiff they may be safely covered up and their existence forgotten. The water formed by condensation at a flange will often cause a leak that would never have occurred if steam only had been present."

When the heat in the gases can be spared water heating by economizers is a great source of economy, increasing the evaporative capacity of the boiler and preventing local cooling and consequent straining. Water heaters of both the open and closed types are most valuable in the case of non-condensing plants.

"Air heating has been tried again and again, but it is very doubtful if it pays. Perhaps the greatest advantage it possesses is in the suppression of smoke, and in that field it certainly has an important place. Smoke prevention has been run hard both by fanatics and by those who are really anxious to see trade carried on upon a commercial basis with the least possible inconvenience either to the traders or to their neighbors. All who have considered the matter will admit that, though black smoke means waste, it is not equally true that a smokeless chimney means economy. On a series of tests, the lowest efficiency was recorded with a minimum amount of air, and the highest with a moderate amount of air, when some smoke was made. Every effort should be made to prevent the emission of smoke, the underlying principle of which is the admission of the proper quantity of air at the proper time, and the removal of cooling surfaces so far as is possible from the gases until combustion is complete, as if the temperature is lowered below the critical temperature before combustion is effected no amount of care in air regulation will prevent smoke. . . .

"It is an unfortunate fact that in many cases an engineer in charge does not really know what his plant is doing, and all for the want of tests which he could carry out himself with very slight expense or inconvenience. Coal may be weighed without appreciably increasing the cost of handling it. Water may be measured by positive meters, which do not need much attention so long as they are not run at a high speed or cut by grit. An interesting and novel type of water-meter is Lea's notched weir, which is very simple and not likely to be put out of action by the causes that affect other water-meters. It is a very ingenious application of an indicating and recording attachment to measure the flow over a V-notch, the value of which was first investigated by James Thompson about fifty years ago. These two measurements, coal and water, give sufficient data for checking the cost of evaporation, which is the most important factor in the works cost of private plants.

"Engine tests appear to have had more fascination for experimenters than boiler tests, but comparison of records goes to show that there is not much difference in the efficiency of different types of boilers which vary largely in design; certainly the figures are not so far part as are the results of tests of similar boilers worked under different conditions. This puts all the stronger emphasis on the necessity of an engineer in charge knowing what his boilers are doing. The more a man knows of his plant the keener will he be to keep its performance up to the highest level obtainable, and nothing shows a staff the capabilities of a plant and secures confidence in it better than a few tests, the educational value of which on all concerned cannot be overestimated."

THE WEATHERING OF COAL.

THE RESULT OF A SERIES OF INVESTIGATIONS TO DETERMINE THE CONDITIONS WHICH PROMOTE OR RETARD THE DETERIORATION OF STORED COAL.

S. W. Parr and N. D. Hamilton—Economic Geology.

A SERIES of investigations on the weathering of coal, the final results of which seem likely to be of considerable practical and economic interest in many industries, is now being carried out by the Chemical Department of the University of Illinois, in co-operation with the Illinois State Geological Survey and the Engineering Experiment Station. In connection with the rapid extension of the practice of storing large amounts of coal in many industries, the question of deterioration is of very vital importance. Storage plants with a capacity of 100,000 tons are by no means uncommon and, although a deterioration of one per cent. in value in

this amount of coal means a loss of 1,000 tons, there is very little exact information as to the conditions which promote or retard the loss of heat value by weathering. It is information of this sort that the investigations now in progress are designed to furnish. The results of a series of preliminary tests made during the past year are given in the following abstract of a report by S. W. Parr and N. D. Hamilton in *Economic Geology* for November, 1907.

"Richter, after extended experiments in 1868, formulated an explanation for the weathering of coal, which does not seem to be disproven by more recent experimenters, to the effect that the weathering of coal is due to the absorption of oxygen, a part of which goes to the oxidation of carbon and hydrogen in the coal, and part is taken into the composition of the coal itself. We certainly need more definite information in order to formulate a final and satisfactory explanation of all the phenomena involved, but Richter's theory conforms to many of the known conditions and indicates the close relationship between the matter of deterioration and spontaneous combustion."

The first series of tests was made on small amounts of coal, in lots of from ten to twenty pounds, and it may be questioned whether deterioration would occur in large heaps at the same rate. It was desired, however to determine only the conditions attending the process of weathering as a preliminary to more extensive quantitative tests which are to follow.

The coal was sampled as soon as possible after it was mined. It was found during the investigation that the early examination of samples to determine initial conditions is a most important point, as deterioration of a certain sort takes place even under the most ideal laboratory conditions. The coal used was of the small lump, or nut size. Each sample of about one hundred pounds was subdivided to subject the same kind of coal to the four conditions of the tests, viz.: (a) outdoor exposure; (b) exposure to a dry atmosphere at a somewhat elevated temperature, from 85 to 120 degrees F.; (c) under the same temperature conditions as (b) but drenched with water two or three times per week; (d) submerged in ordinary water at a temperature approximately 70 degrees F. The periods of examination of these samples as nearly as the work would permit were: (1)an initial analysis of the fresh coal; (2) after exposure for five months; (3) after exposure for seven months. (4) after exposure for nine months, at the expiration of which time the tests were ended. At these periods the calorific values of the samples were determined under uniform conditions by the Parr calorimeter and the results calculated to the ash- and water-free basis. The results of the determinations are given in a series of diagrams which show graphically the changes which took place in each sample.

An examination of the diagrams shows a distinct difference between the submerged coal and the samples exposed to the air. With two exceptions, the samples showed practically no deterioration in the submerged coal, and the values found did not vary more than would be expected with inevitable modifications of conditions of sampling, temperature and manipulation.

The samples subjected to outdoor exposure uniformly showed marked deterioration but of varying amount. The treatment of the samples was identical, the coal remaining in shallow boxes exposed to the various temperature and moisture changes from October to July. The variations in heat loss, therefore, ranging from two to ten per cent, must be ascribed to inherent properties of the coals themselves. All showed a tendency to disintegrate, but they varied distinctly with regard to the ease with which they crumbled under pressure.

The results of the tests on the coals subjected to a dry atmosphere and a slightly elevated temperature were rather unexpected in that, with one exception in which the deterioration was practically the same, they showed a greater deterioration than in the case of outdoor exposure. This would seem to contradict the popular idea that a roof over coal in storage is supposed to be preferable to open exposure. The samples subjected to high temperature with frequent wetting down behaved in general like those exposed to outdoor influences, though in some cases a greater deterioration was observed in the former samples. Here the results are undoubtedly variable in accordance with the variation of structure and

composition of the coals themselves. In general, a greater persistence of value might be expected in the dense and less friable coals and in those with less of iron pyrites throughout their texture.

In conclusion the authors summarize the results as follows:

"(*a*) Submerged coal does not lose appreciably in heat value.

(*b*) Outdoor exposure results in a loss of heating value varying from 2 to 10 per cent.

(*c*) Dry storage has no advantage over storage in the open except with high-sulphur coals, where the disintegrating effect of sulphur in the process of oxidation facilitates the escape of hydrocarbons or the oxidation of the same.

(*d*) In most cases the losses in storage appear to be practically complete at the end of five months. From the seventh to the ninth month the loss is inappreciable.

(*e*) The results obtained in small samples are to be considered as an index of the changes affecting large masses in kind rather than in degree, but, since the losses here shown are not beyond what seems to conform in a general way to the experience of users of coal from large storage heaps, they may be not without value as an indication of weathering effects in actual practice."

LARGE GAS ENGINES IN GERMANY.

INTERESTING DATA ON THE EXTENT AND RESULTS OF THE USE OF GAS ENGINES IN METALLURGICAL WORKS.

R. E. Mathot—Revue de Mécanique.

IN Germany the rapid development of the large gas engine has been largely due to its introduction for the utilization of blast-furnace or coke-oven gas in the iron and steel industries. In a review in these columns in October, 1906, it was noted that at that time, out of 49 iron works in Germany, 32 had already installed gas engines and 9 had ordered them. In the following extracts from an article in the *Revue de Mécanique* for November, 1907, M. R. E. Mathot reports further extension of their use in metallurgical works and gives some interesting data of the results obtained.

Of the 50 large iron works in Germany 45 have already installed gas engines for the utilization of the waste gases of the blast furnaces and coke ovens or are preparing for their introduction. These represent altogether 350 units, designed to develop a total of about 400,000 horse power. The largest of these installations is of 35,000 horse power and there are 15 which vary between 10,000 and 15,000 horse power. In some few cases the plants have been laid out so as to permit the installation of gas producers in case they are needed to keep the engines working at their full capacity.

In collieries and coking plants the strife between the internal-combustion motor and the steam engine has been less marked on account of the large number of old coke ovens in use, from which the gas available can be used only for raising steam under boilers. Nevertheless in such plants there are now about 25 to 30 motors either working or about to be installed, developing a total of from 40,000 to 45,000 horse power. The greater part of the gas engines employed in blast-furnace plants and in collieries are of the double-acting type, some of them being two-cycle and some four-cycle. The latter are more generally used, however, on account of their high efficiency.

The increasing favor which the gas engine is finding in the metallurgical industries is easily explained by the following figures: an ordinary blast furnace with an output of 100 tons of pig per 24 hours produces almost 9,000 cubic metres per hour of gas available for power generation with a calorific value of about 1,000 calories per cubic metre. This amount of gas if used for raising steam could develop about 2,500 horse power while, used in gas engines, it develops 4,200 horse power, an increase over steam engines of 1,700 horse power or 70 per cent.

Such excellent results as these cannot be obtained, however, unless the plant is provided with all modern improvements, among which the most important have to

do with systems of cleaning the gas. Cleaning devices have of late been given a great deal of attention by both constructors and users of gas engines. To clean the gas of the impurities it contains, such as dust, tar and chemical products prejudicial to the satisfactory working of the gas engine, and to reduce the temperature of the gas before its admission to the cylinder, a complete washing, a purification, and a cooling process are necessary. These operations are performed by means of fans, rotating washers or similar devices which use 1.5 to 2 litres of water per cubic metre of gas cleaned. It is possible by this means to reduce the dust content of the gas from 3 grammes to 0.2 grammes per cubic metre.

The power required to drive the fans and washers depends both on the system adopted and on the amount of impurities to be eliminated and varies between 2.5 and 8 horse power or on the average about 3 per cent. of the power contained in the gas. The cooling water necessary for the motors themselves, per horse-power hour, varies between 8 and 12 litres for the piston and piston rod, and 30 to 40 litres for the cylinder casing, valve seat, etc. The oil necessary for the lubrication of a good engine should not exceed 1 to 1.5 grammes per horse-power hour.

In order to realize as completely as possible one of the indubitable advantages of the steam engine with which the internal-combustion motor has to compete, the latter are designed to give a large margin of power. They are usually designed for a pressure of about 5 kilogrammes per square centimetre for normal and constant working although the excellent construction of the motors permits of the use of a pressure of from 6 to 6.5 kilogrammes per square centimetre. So far as fuel economy is concerned a thermal efficiency of 30 per cent. is attained. This almost corresponds to the production of an effective horse-power hour with 2,100 calories, as well in the small single-acting motors as in the large double-acting machines, working on a normal charge.

The regulation of the motors is effected by variation of the mixture admitted to the cylinder in each cycle, either by changing the volume with constant composition, varying the composition of a fixed volume of gas, or by combining these two methods. The first method implies a variable compression and, as a consequence, some loss due to the partial vacuum produced in the cylinder with small charges, but this is offset by the high power output of all the charges. The second method, although it appears less economical, possesses certain mechanical advantages. The third method, according to its advocates, possesses all the advantages of the two former methods with none of their disadvantages. The two systems combined, however, lead to a complication of mechanical details and it is a question whether, on this account, the operation of the engine is more satisfactory. The large gas engines are, in general, of the double-acting, tandem, horizontal type.

THE TESTING OF HEAT-INSULATING MATERIALS.

A DESCRIPTION OF SMALL AND CONVENIENT APPARATUS WHICH GIVES RELIABLE RESULTS IN SMALL-SCALE TESTS.

Charles R. Darling—Engineering.

IN *Engineering* for December 6, 1907, Mr. Charles R. Darling describes a simple and efficient piece of apparatus for the testing of heat-insulating materials under working conditions, which should prove of great interest and value to managers of steam plants. As Mr. Darling points out, tests such as are conducted on a small scale in the works laboratory are usually devoted to the determination of the absolute conductivity of the material and, while this is of importance, it can serve as only a partial guide and may be very misleading as to the behavior of the material under working conditions. While there are other methods of testing which will give accurate results, for example, those of coating a length of pipe with the insulating material and heating either by passing steam through the pipe or by an electrical resistance, the apparatus is too bulky for use in the ordinary plant. In the

apparatus devised by Mr. Darling, described in the following extracts, reliable tests can be made on small quantities of material with an accuracy equal to that obtained with the larger and more costly methods of testing.

"The testing chamber is an air-tight copper vessel, cylindrical in shape, the height being 8 inches and the diameter 6 inches. This vessel is completely covered with the material under test of uniform thickness. The source of heat is a 32-candle-power incandescent lamp, without capping, the leads from which pass through a stuffing-gland, which may be removed to permit of the entrance of the lamp into the vessel. A voltmeter is placed across the lamp terminals, and an ammeter and rheostat are inserted in one of the wires leading to the mains. A brass tube communicates with the interior of the cylinder, and is connected by means of a glass tube and a piece of flexible tubing to a mercury cistern. This arrangement enables the internal temperature of the cylinder to be determined by the pressure of the enclosed air, on the well-known principle of the constant-volume air-thermometer; and as the average pressure is registered, the true average temperature will be obtained. As the temperature rises the cistern is raised, so as to keep the mercury at a fixed mark on the glass tube, the increase in pressure being measured by reading on a scale the difference between the starting and final level of the mercury in the cistern. A cup, furnished with a tap, and communicating with the interior of the glass tube, contains a drying material, which prevents the entrance of moisture; and on opening the tap the enclosed air attains the pressure of the atmosphere and the mercury stands at the same level in the tube and cistern. The whole arrangement will be recognised as a gas-pressure thermometer, of which the copper cylinder constitutes the bulb.

"In commencing a series of readings, the tap is opened and the height of the barometer noted. The temperature of the cylinder is obtained by means of an accurate thermometer, placed in contact with the lid beneath the lagging, and allowed to remain until stationary. The cistern is then moved until the mercury in the tube is opposite the fixed mark, and the scale reading opposite to the level of the mercury in the cistern is noted. The difference of level which must subsist between the starting and final positions of the cistern may then be obtained for any given temperature by calculation, or reference to a suitable table. For example, if a temperature of 180 degrees Cent., corresponding to 146 pounds absolute steam pressure, were required, the barometer standing at 765 millimetres, and the temperature of the cylinder at starting being 10 degrees Cent., the required difference of level would be 45.4 centimetres, or 17.8 inches. The tap is now closed and the current turned on full—the resistance being cut out—and the temperature allowed to rise until the pressure exceeds that required by 2 or 3 centimetres; the cistern having been raised at intervals, so as to keep the mercury at the mark in the glass tube. A portion of the resistance is now brought into the circuit, and the temperature allowed to fall gradually until the correct value is indicated by the mercury level in the cistern. If the resistance has been carefully adjusted, the temperature will remain steady; and when stationary for 10 or 15 minutes the readings of the ammeter and voltmeter are taken. This process may be repeated at intervals of 10 degrees by carefully increasing the resistance, and the heat passing through the lagging obtained in each case by reading the ammeter and voltmeter, and making use of the expression

$$\text{Volts} \times \text{amperes} \times 0.24 = \text{calories per second,}$$

or

$$\text{Volts} \times \text{amperes} \times 0.057 = \text{B.Th.U. per minute.}$$

An equal thickness of a second material may now be substituted, and the observations repeated. The experiments should be carried out in a place not liable to large fluctuations of atmospheric temperature.

"The author has subjected the apparatus described to an extended trial, and has found it accurate and easy of manipulation. With any good form of lagging, ⅝ inch thick, a range of temperature from 220 degrees Cent. downwards may be achieved, thus ensuring that the test may be performed at working steam temperatures. Higher temperatures still may be obtained by the use of a greater thickness of the

material. For lower temperatures, such as 130 degrees Cent. and downwards, a 16-candle-power lamp is used in place of the 32 candle-power requisite for the higher range. The readings may, by the use of proper instruments, be made very sensitive; the change in temperature occasioned by an alteration of 1/100 ampere being detectable. For direct-current circuits, working from 100 to 110-volt mains, a moving-coil ammeter—range, 0 to 2 amperes, and capable of being read to 1/100 ampere—will be found suitable; for 210-volt mains a range of 0 to 1 ampere suffices. Moving coil voltmeters having a range of 60 to 110 volts, or 120 to 220 volts, according to supply, are also well suited to the purposes of the test, and should permit of being read to 0.5 volt. For alternating circuits hot-wire instruments of the same range and delicacy of reading may be substituted. A continuous wire resistance of range 0 to 250 ohms will permit of the necessary adjustment on any of the above circuits.

"The author is of opinion that this test will prove of great service, not only to the makers of boiler and steam-pipe coverings, but also to engineers in general, in enabling them to decide on the best type of cover for any given purpose. It is proposed to publish, at a later date, the results of tests made with various commercial types of lagging, together with the effects of thickness, atmospheric temperature, and nature of surface on the efficiency. No reliable information on these points exists at present, as it has not hitherto been found possible to obtain satisfactory data without the use of apparatus too large and elaborate to permit of the carrying out of the observations involved in a reasonable time. The contradictory assertions in published reports of tests are sufficient to indicate that a standard method of procedure is urgently needed, and the author ventures to hope that the apparatus described will help to place our knowledge of the subject on a better scientific basis."

THE ZIEGLER SYSTEM OF PEAT UTILIZATION.

A DESCRIPTION OF THE LATEST PLANT FOR THE BY-PRODUCT COKING OF PEAT RECENTLY ESTABLISHED AT BEUERBERG, BAVARIA.

Engineering.

TO the problem of the utlization of peat, which is now attracting so large an amount of attention in the United States, Continental practice offers two solutions. The latest, that of gasifying the peat in the gas producer with recovery of by-products, the results of which were presented in these columns in THE ENGINEERING MAGAZINE for December, 1907, is particularly adapted to cases where the demand for power outweighs all other considerations. The Ziegler system of by-product coking has been brought to such a stage of perfection, however, that the excellence of the coke and by-products obtained may cause it to be preferred in many localities in the United States and Great Britain. The following description of the latest development of this system in a large plant at Beuerberg in Pavaria is taken from *Engineering* of November 15, 1907.

The by-products obtainable are of great variety and excellence and find a ready sale. "The farmers readily buy the ammonium sulphate, while chemists are quite aware of the value of the peat tar, because it resembles the lignite tar and yields, like it, tar proper, pitch, phenols, paraffin, acetic acid, and methylated spirits, and the peat coke can replace charcoal as a preserving and absorbing medium. These statements may not be of particular interest to the engineer, but what will directly appeal to him is the fact that peat-coke proves itself quite equal, if not superior, to charcoal in the metallurgy of iron and steel, and in the hardening and welding operations of armor-plate and engineering works, and also that it gives smokeless briquettes for marine boilers. There is undoubtedly a great opening for peat coke, which many districts will be able to produce at low cost in substitution for the now scarce charcoal. There is, further, the peat power-gas, and in addition still another side to the problem. It has been found in several localities—and, for in-

stance, at Beuerberg—that the clay underlying the peat bogs will, when mixed with the sand also occurring in those strata, yield an excellent farming soil. Thus we may hope to convert the 1860 square miles of bog of Ireland into productive ground, and to raise and nurse industries at the same time."

Ziegler developed his process from that of the distillation of lignites and his first plant was built at Oldenburg in 1897. Though the financial results were not satisfactory the technical success of the process attracted so much attention as to be made the subject of a special investigation and report by a Commission appointed by the Prussian Government. The next plant built by Ziegler was at Redkino, in Russia, but the projected auxiliary chemical works were never completed. In 1905, however, all the Ziegler patents were taken up by a company and the large works at Beuerberg, about 24 miles south of Munich, which embody the latest improvements in the system, were opened in 1906. The plant is situated on the edge of a large peat moor which at the present rate of working will furnish raw material for the next 40 years.

A large factor in the success of this plant has been the adoption of electric power throughout. Portable elevator huts, each containing a Dolberg peat process run by a small motor, follow on light tracks the progress of the cutters. The peat as cut with the spade is thrown on an elevator which conveys it to the press. From the two nozzles of the latter, two strings of pressed peat emerge, each about 4 by 4¼ inches in section. These are caught on wooden pallets and are cut into blocks about 16 inches long. The pallets are then conveyed on trucks to the drying ground where the peat is left until the moisture content is reduced by air drying to below 25 per cent, the blocks being piled in heaps as they become hard enough to handle. When fully dried the blocks are trucked to the furnace house, a four-story structure, where they are elevated to the charging floor in the top story. Two types of furnace are installed which are described as follows:

"The two furnaces of type I are vertical kilns, about 40 feet high. Each kiln represents a pair of retorts approximately semi-circular in section. The lower portion of the kiln, from which the coked peat is withdrawn by means of a helix, is common to both the retorts. But the chief part of the kiln is subdivided by a vertical partition, which forms a system of flues, and the whole kiln is jacketed with flues. The hot gases which circulate in these flues have a temperature of 1000 degrees C. (1832 degrees F.), while the temperature in the retort itself does not rise above 600 degrees C. (1000 degrees F.). The retort is thus completely surrounded by flues, and the construction of the furnaces is not simple. About 10 feet above the lower level are the auxiliary grates, which are charged with dry peat at the commencement of operations, to start the furnace. Next to these grates are the three auxiliary lower gas furnaces, which are fired with the flue gases which are escaping above. About 6 feet above we find two more of these gas furnaces. In the upper portion of the kiln there are two pipes—one for each retort—which establish connection between the flues and the interior of the retort by means of dampers. With the aid of these dampers or other devices, the operations can be so regulated that the peat will be dried in the one retort of a pair, while coking goes on in the other retort, and the different furnaces, inlets, and flues permit of regulating the temperature. While drying is going on, the vapours are discharged into the chimney; afterwards the gases are sent into a system of piping for the recovery of the chemical products, with purification of the power-gas.

"The charging takes place on the top floor. Each retort has its fill-hole, an iron pipe luted with clay and alabaster; the fill-holes are usually kept closed, and they are covered by a big cowl, from which the gases and vapours are withdrawn to join the other flue gases. Steam can be injected to keep out the air during charging. The peat is put in with the shovel at intervals, and steam is injected into the furnace to keep the air out during this operation, while the admission of the flue gases is stopped. The charging arrangements of the furnaces of type II. are improved. The hot coke is drawn off below. The air-dry peat sods are quite hard, and

not likely to crumble in the kiln. The charge remains in the kiln for about 18 hours, and from 8 to 10 tons of peat-coke are gained per day of 24 hours. The coke falls into trucks, which are closed by lids. The trucks are run out into the yard, where they cool sufficiently in six or eight hours to be taken into the sorting-shed.

"The furnaces or kilns of type II. serve for the rapid partial coking of peat, which cannot be sufficiently air-dried for use in the retorts of type I. They are round shaft kilns of the same height as the other furnaces (40 feet), and differ from them chiefly in so far as the flue gases from type I., or from some independent source, enter directly into the interior of the kiln, to dry and to gasify the peat. The shafts are not jacketed with flues, but are subdivided to a certain extent by two or more iron plate-rings fitted into the wall; these rings may be likened to the necks of bottles, widening out above. At Beuerberg the type II. furnace is worked in conjuncton with type I., as already explained; special coils for producing superheated steam are embedded in the jacketed walls of the furnace of type I. The flue gases (together with superheated steam) are admitted at two spots, beneath the iron rings mentioned. At first the valve under the upper ring is opened, while the outlet on the top of the furnace is also kept open. When the moisture is expelled from the peat, and tarry vapours make their appearance, the flue gases are made to enter under the lower plate, and the escaping vapours and gases are collected. The resulting power gas is not so rich as that of the retorts of type I., but it can be used in gas-engines. From 12 to 14 tons of semi-coke are produced in 24 hours." This semi-coke is a good substitute for coal and, while it burns with a flame, it produces hardly any smoke.

A description is given of a third type of furnace invented by Ziegler and others for the production of power gas and chemicals from inferior peat, which has recently been tried with satisfactory results at the Fleiss Iron and Steel Works at Shelecken. The recovery of the by-products from the flue gases is then outlined. From a diagram it is learned that the amounts and values of the various products of the process from 1,000 tons of raw peat are as follows: 350 tons of coke at £2 per ton; 4 tons sulphate of ammonia at £12 per ton; 6 tons acetate of lime at £6 to £8 per ton; 2 tons methyl alcohol at £35 to £45 per ton; 8 tons crude paraffin at £22.10.0 per ton; 4 tons fine paraffin oil at £10 per ton; 18 tons gas oil at £5 per ton; 2 tons pitch at £2.10.0 per ton; and 2 tons creasote oil at £3 per ton.

The demand for peat coke in Germany far exceeds the supply. A number of the largest steel makers have adopted it as a substitute for charcoal in case-hardening and other processes.

"Of the ashes of the peat-coke nearly half is silica, bound together chiefly by lime and alumina; carbonates, sulphates, and phosphates make up together a small percentage, and in the other bases are iron oxide, magnesia, and alkali. Calculations for the coke show that the sulphur contents ranged from 0.101 to 0.117 per cent., and the phosphorus contents from 0.058 to 0.009 per cent. The composition of the ashes as well as of the peat, varies, of course, with the local conditions; but, so far, the peat-coke ashes have proved suitable for metallurgical applications, as they yield a slag of low melting-point, and the percentages of sulphur and phosphorus are small.

"The peat coke is produced in blocks 6 by 4 centimeters, and from 10 to 25 centimeters in length (2½ inches by 1¼ inches and 4 inches to 10 inches.) It is a hard, dense material, not betraying its origin in appearance, dull black in color, and hardly porous. It may be obtained as firm as, and ringing like, coal-coke, particularly if the peat is well dried before entering the furnace. The peat-coke retains its heat better and burns much less rapidly than charcoal, and does not spark or burst; it can therefore replace anthracite, when applied in small pieces, and is recommended for welding, soldering, and brazing. The peat-coke from the first Oldenburg plant answered very well as a substitute for charcoal in the iron works at Schmalkalden, and this experience has been confirmed in the Ural and in other places. The excellent reputation of Swedish iron is largely due to the use of charcoal in the furnaces; and the peat-coke is claimed to be at least

equal to charcoal in this respect, and more economical in use, apart from its lower price. A new combined peat-coke and blast-furnace plant is now in course of erection near Oldenburg, where bog ore and Swedish ore are to be smelted. The blast-furnace is to be 21 meters high and 6 meters maximum width (69 feet and 20 feet), and will produce 150 tons of pig daily. The peat-coke will be made in nine double-retort furnaces, each furnace to yield 9 tons of coke daily."

A CENTRAL RESCUE ORGANIZATION.

A DESCRIPTION OF THE EQUIPMENT AND TRAINING FACILITIES FOR RESCUE WORK IN THE AACHEN DISTRICT IN PRUSSIA.

Professor Stegemann—Glückauf.

FOUR coal-mine explosions within as many months, resulting in the loss of nearly a thousand lives, have brought forcibly before the people of the United States the necessity for strict inspection and regulation of mining methods and conditions if this shocking and unnecessary waste of life is not to continue. On another page of this issue Messrs. Hall and Snelling of the United States Geological Survey draw a striking parallel between conditions in European countries, where the loss of life has been decreasing steadily under efficient inspection and careful investigation of mining conditions, and the United States in which fatalities have become more numerous year by year. They indicate clearly the lines along which improvement of methods and regulations is necessary. It is hardly to be expected, however, that, even with the most perfect precautionary and preventative measures, accidents can be entirely eliminated and it must not be forgotten that the provision of adequate equipment for rescue work is of almost equal importance with the establishment of improved methods and efficient inspection. In view of the extreme difficulty under which rescue work was carried on after the recent disasters, the following description of a central rescue station lately established at Aachen, which shows the extent to which rescue work has been developed in Prussia, should amply demonstrate the great benefit which might be expected from the introduction of such equipment and methods of training in the coalfields of the United States.

The system of mine inspection boards which exists in Germany is described by Messrs. Hall and Snelling. Prof. Stegemann points out that these boards are inclining more and more to the establishment of more stringent rules for the provision of rescue appliances and their use is now common in many districts. For a long time only the Breslau district board prescribed the provision of rescue appliances at all the mines in the district, but within the past year a large number of other commissions have followed this example, one of the most recent being the Bonn district board, whose ordinance went into effect October 1, 1907. It is provided here that "at least two rescue apparatus, rendering possible entrance into noxious gases, must be kept at hand or easily procurable at each hoisting shaft and that it is the duty of the manager to see that these apparatus are always in working order and that a sufficient number of superintendents and miners are instructed in their use."

In the Aachen district mine fires are extremely rare, as the coal has no tendency to spontaneous combustion, and explosions of gas and dust are proportionately infrequent. Notwithstanding these favorable conditions, however, the Aachen Coal-Mining Association has been considering the subject of rescue appliances for some time, impelled thereto by the disasters at Courrières and Borussia, which proved conclusively the practical utility of rescue appliances. The scheme finally agreed upon was the building of a central rescue station to serve the whole district which covers a comparatively small area. The district has really two divisions, the mines on the west, on account of the hard, almost anthracitic quality of their coal, being much less hazardous than those on the east, with their open-burning and fat coals. A site was given for the station near the shaft house of the Maria, the central mine

of the eastern division, where the Association already has an explosive testing station.

The scheme of the building provides for a large storage room for the apparatus which also serves as a cleaning and repair room, a large two-story drill hall, a dressing and bath room, a room for the apparatus wagon, and an office for the official in charge of the station. It is connected to the drainage, water, steam and lighting systems of the mine.

The drill room, which is, of course, the most important feature of the station, is 20 metres long and 7 metres wide. The practice galleries in two stories are built in a horse-shoe shape around a central observation room, and the width of the building permitted the building of a third gallery along one side of the building. All the passages are connected by shafts and inclines and give a total practice length of 120 metres. The whole interior of the drill hall is designed to give the impression of a mine on a small scale and, to make the drills interesting, the interior arrangements are altered from time to time. Wood and iron were used exclusively for its construction, the only brickwork being in the smoke producer. On the floors of the galleries are placed haulage ways with turntables; ventilation, drainage and compressed air pipes are installed, air doors are erected and a fall of the roof indicated, etc. For the production of smoke, hair refuse, cotton waste, etc., are used, these materials being stored in a small room near the producer. As a precautionary measure all the galleries on both floors are equipped with safety doors. As in other rescue stations work-measuring instruments are installed, in this case the devices being self-recording. In the wagon room the apparatus wagon will always stand ready for immediate service. Whether the wagon will be drawn by horses or will be driven by a motor is as yet undecided.

The rescue appliances consist of two hose and twelve oxygen apparatus, namely, one each of the Original König Nr. III and Westfalia devices of the hose type, each for two persons, and six each of the Westfalia and Draeger oxygen-generating appliances arranged for both mouth and helmet breathing. The Pneumatogen device has been entirely abandoned, its peculiar disadvantages outweighing the advantage of light weight.

In all, nine rescue divisions have been trained for the mines of the district, the number of trained men now amounting to one per cent. of the total number of miners. When the rescue corps was first organized 110 men were admitted. In choosing them only trustworthy and enthusiastic men were considered, the first choice being given to the mine superintendents as being most familiar with the layout of the mines underground, and after them the mine foremen, fire bosses, and lastly the ordinary miners and laborers. All the men were subjected to a physical examination, and it was taken into consideration whether they lived near the mine, were easy to reach in case of need, and worked distributed in various parts of the workings. Each rescue division is placed under the general leadership of the oldest superintendent, but they are divided into groups of five, each group being under the command of a group leader. The direction of the training as a whole lies in the hands of a mine inspector especially appointed for this purpose and trained in the theory and practice of rescue work at the Bochum school. Herr Stegemann, as manager of the mines, has a general oversight over the rescue work.

The training begins with a general course to the whole corps on the design, construction and use of the rescue appliances. Following this the practical training takes place in groups and consists of ten two-hour drills. The aim of the whole course of training is to get the men so used to the apparatus as to have perfect confidence in them and willing to make the fullest possible use of them in case of need. The drills are graduated as follows:

(1) and (2) with the hose apparatus.

(1) in the open; putting on and carrying apparatus (½ hour); breathing under air pressure (½ hour); the performance of light work under air pressure (1 hour).

(2) in the drill room; exploration of the galleries without smoke (½ hour); with smoke (½ hour); the performance of light work (1 hour).

(3) to (10) with the oxygen apparatus; (3) to (5) in the open; (6) to (10) in the drill room.

(3) Putting on and carrying the Draeger and Westfalia apparatus with and without helmet, natural breathing, each ½ hour.

(4) the same as (3) under artificial respiration.

(5) the same performing work.

(6) Carrying the apparatus and working in the drill room without smoke and with natural breathing, in other respects like (3).

(7) Same as (6) with smoke and artificial respiration.

(8) Performance of work using the Draeger apparatus, 1 hour each for mouth and helmet types.

(9) Same with Westfalia apparatus.

(10) Two hours' continuous drill in the smoke-filled chambers, the men being required to make five tours of the galleries and do 10,000 kilogramme-metres of work, apparatus and breathing methods being left to their individual choice.

When this course of training is finished the men will be kept in condtion by means of quarterly drills which will extend to other work, such as the rescuing of victims, etc. This part of the training will take place partly in the drill room, but for the most part with the use of the apparatus wagon at the various mines of the district.

THE VOLUMETRIC COMPOSITION OF CAST IRON

A DISCUSSION OF THE COMPOSITION OF CAST IRON WITH REFERENCE TO THE PROPORTION BY VOLUME, INSTEAD OF BY WEIGHT OF THE IMPURITIES PRESENT.

Henry M. Lane—American Society of Mechanical Engineers.

AN interesting theory to account for many of the seeming contradictions in the behavior of alloys was put forward by Mr. Henry M. Lane at the December, 1907, meeting of the American Society of Mechanical Engineers. Mr. Lane pointed out that engineers are accustomed to speak of the percentage of impurities present in alloys with reference to the weight of the entire mass, to the exclusion of all consideration of the relative volumes occupied by the pure metal and the impurities. Taking the particular case of cast iron, Mr. Lane suggests that this volume relation offers a satisfactory explanation of many otherwise inexplicable phenomena, as, for example, the fact that the microscope cannot be applied to the study of cast iron with the gratifying results which have followed its application to the metallurgy of steel. The following abstract gives an outline of Mr. Lane's argument:

"Cast iron in its various forms may be considered as an alloy. By weight it rarely contains more than 94 per cent. metallic iron or pure iron, and in some cases scarcely more than 90 per cent. Many attempts have been made to account for the apparently disproportionate effect produced by the additon of comparatively small amounts of impurities. If, however, we consider the relative volumes occupied by these impurities by themselves, and also the volumes probably occupied when in combination with the cast iron, we obtain an entirely new light upon the subject.

"The ordinary No. 2 foundry iron contains 2 per cent. of silicon, 0.04 per cent. of sulphur, 0.70 per cent. phosphorus, 0.70 per cent. manganese, and 3.50 per cent. carbon; or a total of 6.94 per cent. of the principal so-called impurities. . . . Manganese is a metal very closely related to iron, and having nearly the same specific gravity, and hence when it is alloyed with iron it changes the volume of the mass but little. Some of the other elements, however, behave very differently. Pure silicon has a specific gravity of less than 2, while iron has a specific gravity variously reported from 7.77 to 8.0. This means that a given weight of pure silicon occupies four times the volume of a given weight of iron; therefore we may call the volume factor for silicon, 4. In like manner we find that sulphur occupies more than four times the volume of iron, and its volume factor would then be 4.07. The volume factor for phosphorus would be 4.44, and the volume factor for manganese 1.01. Carbon in the graphitic form, which is practically the condition in which it occurs in grey cast iron, occupies more space than any other of the constituent elements, and its volume factor would be 6.79. Using these factors, we may make some very in-

teresting calculations concerning some of the more common iron mixtures, and these will lead us to an understanding of a number of the peculiarities of castings."

A table is given of the percentages by weight and by volume of the elements other than iron, viz., silicon, sulphur, phosphorus, manganese and carbon, contained in No. 2 foundry iron, stove plate, machinery iron and malleable iron, of ordinary average composition. The analyses on which the table is based were made on standard brands in an endeavor to show average conditions as far as possible. The percentages of impurities found in these classes of iron, by weight and by volume, the volumes being calculated from the volume factors given above, were as follows:

	By weight.	By volume.
No. 2 foundry iron.....	6.94	35.73
Stove plate	7.52	41.22
Machinery iron	5.90	34.01
Malleable iron	4.09	24.19

These volumetric relations are also shown graphically and Mr. Lane then proceeds to give practical proof of the fact that the impurities in cast iron actually do occupy so large a part of the volume of the total mass.

"This has been very nicely proved by an actual demonstration in which as much of the iron as possible was removed from the castings by a long pickling in dilute hydrochloric acid. The pickle was a wash used for dipping the castings into previous to nickel-plating. Some castings fell by accident to the bottom of the vat and remained there several months. When they were removed it was found that they were exceedingly light; and while they looked exactly like iron castings, they were brittle and very difficult to handle without breaking. An analysis showed that by far the largest portion of the iron had been removed by the pickle, and hence the remaining constituents formed simply a skeleton or sponge."

Several other examples are given of the results of pickling on castings. In all cases careful measurements show that the dissolving out of the iron made practically no change in the size of the casting. It is also interesting to note that the resulting spongy castings show the character of the original castings remarkably well. In them the dividing plane along the center of the casting due to its solidificaton from the outside in, which is not noticeable in the solid iron, can be clearly traced.

Among the phenomena which Mr. Lane mentions as explained by this theory is the fact that a long annealing of a malleable iron casting in the presence of an oxidizing medium results in a greatly weakened casting. This is because by long annealing practically all the graphitic carbon is removed from the casting and about 20 per cent. of the bulk of the casting is taken up by the resulting voids. Annealing would also result in the oxidation of a part of the iron and this would be another source of weakness. Mr. Lane offers this as the true explanation of the fact that the strongest malleable castings are produced by heating just above the recalescence point and holding there merely long enough to convert all of the carbon from the combined to the temper form, without any loss of this element.

The paper brought out a very interesting discussion, the following report of which is taken from *The Foundry* for January, 1908:

"The ensuing discussion brought out a very general disinclination to accept the theories set forth by Mr. Lane. Mr. Johnson, the first speaker, said that both in theory and practice the paper was absolutely in error so far as malleable castings were concerned. Carbon can penetrate through iron, he continued. The only part of the malleable casting which is worth anything is the outside skin, which is decarbonized. The casting otherwise might almost as well be hollow, except for the opposition offered to collapse. Volumetric study, he concluded, was without basis, except so far as it concerned the graphitic carbon in cast iron.

"Mr. Lane was questioned in regard to the nature of the pickling bath in which several small castings entering largely into his discussion had remained a number of months. He said it was very dilute hydrochloric acid, about a 1 per cent. bath. Mr. Keep said this acid was used to take the silicon off the casting. A sulphuric acid bath is also employed, but in time hydrochloric acid will disintegrate iron. Mr. Outerbridge offered a written discussion, describing the action of the weak acids in the bilge water from the hold of a freight steamer in producing an effect on a cast

iron strainer similar to that described by Mr. Lane, and cited another case where oil refiners' acids had so changed the character of a cast iron pipe that picks penetrated it without difficulty.

"Prof. Stoughton said that Mr. Lane's theory was interesting, whether correct or not. It would hold, in his opinion, for graphitic carbon, but not for the other elements because they are in a combined state. Graphitic carbon does occupy space and therefore is of interest. He told of the theory advanced by Sir William Austen dealing with the molecular volume of impurities and stated that this bore many points of resemblance to that offered by Mr. Lane. The former was put forth many years ago. Prof. Stoughton also took issue with the author of the paper over the statement made in its presentation that the microscope was of little value to the foundryman. It has already helped the foundryman greatly, he declared, and can be of as much or even more assistance in the foundry as in steel works, all of which, provided they are of any considerable size, are now equipped with a complete microscopic department. The problem of the iron foundryman is much more complex than that of the steel founder and therefore the microscope can properly be applied and will prove of much importance. He cited the case of a concern operating a number of gray iron foundries having taken up within a year the microscopic study of cast iron. In refutation of the statement made by Mr. Lane that the microscope is of little value in the foundry, Prof. Bradley Stoughton supported his contention that the contrary is true with a large number of lantern slide illustrations of micrographs of different grades of iron and steel. Another speaker, in closing the discussion for the morning, said that Mr. Lane had given a few facts, but that the further value of his paper was entirely negatived by his failure to take into consideration the fact of the elements combining."

THE ELECTRIFICATION OF THE SWEDISH STATE RAILWAYS

THE LEADING FEATURES OF THE PROJECT FOR THE ELECTRIFICATION OF THIRTEEN HUNDRED MILES OF RAILWAY IN SOUTHERN SWEDEN.

Engineering.

A PLAN for the electrification of steam railways on a more extended scale than in any similar project hitherto attempted has been prepared under the official direction of the Swedish government and there is every indication of its being carried into effect. For the last two years a series of very thorough investigations on the practicability and economy of trunk-line electric traction has been carried out and the results have amply demonstrated the suitability of the system to the demands of the Swedish railways and have afforded a basis for the exact and exhaustive calculations on which the favorable report mentioned above is based. *Engineering* for December 13, 1907, publishes an abstract of this report of which the following extracts give the leading features.

"The decision in question affects all the railways south of Bollnäs (some 150 miles north of Stockholm), with the exception of the three following lines: Laxa-Charlottenburg, Orebro-Svarta, and Gothenburg-Stromstad, which sections for sundry reasons have not been included in the report. The large system of railways that comes under the scheme will, it is proposed, be supplied with electricity from five power stations at the Karsefors, the Trollhättan (both on or near the West Coast), the Motala, the Hammarby (having a central position), and the Alfkarleby Fall (near the East Coast and more northerly than the rest). The number of transformer stations is about thirty-five. It is distinctly pointed out that as the electric working is more economical with a large traffic, the calculations based upon the present available statistics do not compare favorably with what may be the state of affairs some years hence, when the electrification may have been brought about.

"The traffic mileage of the railways included in the present scheme amounts in the aggregate to some 1,300 miles, of which there are 1,230 miles single line, seventy

miles double line, besides 440 miles of sidings. Owing to the increase of the traffic it will, no doubt, be necessary to build more double lines and to increase the mileage of the sidings. This latter increase is put at forty-five per cent, and it is taken that the lines on which an increase of sixty per cent in the traffic (which, according to recent experiences, may be expected by the year 1920) makes the increase necessary, carry an annual traffic of 300,000 carriage-axle kilometres per kilometre of rail, and would have been transformed into double lines by the year 1920. On this basis the lines Stockholm - Gothenburg, Stockholm - Bollnäs, Katrineholm - Malmö and Hallsberg-Frövi will have been made double-tracked at that time. This surmise, it is pointed out, makes the calculations look less flattering, inasmuch as the cost of the electric conductors is only slightly increased through increased traffic, while the second road means an increase of cost under that head of forty per cent. A larger calculated increase in the traffic of, say, 100 per cent or more would also make the calculations look better than one of sixty per cent."

Single-phase alternating current will be used and the conductors will carry a pressure of 50,000 volts in the feeders from the power stations and 15,000 volts in the contact wires. Both power and contact wires will be carried on the same poles, the former some distance above the latter to facilitate repair work. The poles will be spaced 83 feet apart and will be placed alternately on the right and left side of the railway. The contact wires, 65 square millimetres in section on main lines and 50 square millimetres on sidings, will be placed 20 feet above the surface of the rail except in tunnels and under bridges. The estimates include the raising of tunnels and bridges to a height of 18 feet. Between the water falls and the railways the power will be transmitted on two lines of wires, independent of each other, carried on iron supports with concrete foundations spaced 366 feet apart.

"All the transmission lines are calculated to be constructed with as complete reserve arrangements as possible. From all the power-stations except the one at Hammarby the transmission lines will proceed in two directions, and, as already stated, each with two independent sets of wires. From the point where these wires reach the railway double power lines will be installed, one on each side of the railway. These power-lines will feed the transformer stations, of which there are to be thirty-seven, lying along the railways at a distance of some 30 miles from each other. These transformer stations in their turn will feed the contact-wires in two directions, so that each point, under ordinary circumstances, receives current from two sides. The contact-wires on a few shorter sections, which only receive current from one side, will have instead two feeding-wires, coupled parallel with the contact-line, one on each side of the railway. Each of the four power-transmitting wires running along the railway will be able to be automatically switched off between each two transformer stations. These four 15-millimetre square wires will also go to those parts of the railway which are furthest away from the power-station, and which consequently adjoin the area of the next power-station in order to enable the one power-station to help the other by taking over the working of the nearest portion.

"The wires along the railway are so calculated that the normal maximum decrease of pressure, even with the most unfavourable train arrangements, shall not exceed 15 per cent., inclusive of 4 per cent. drop in the transformers of the sub-stations. These calculations are based upon the highest possible number of trains and of weight per train, and the most unfavourable position of the trains. . . . . .

"Water-power stations are proposed, built at the Karsefors Fall, in the River Lagan; Trollhättan Fall, in the Göta river; Motala river, between Norrby Lake and Roxen; Hammarby Fall, in the River Jäslean, and Alfkarleby Fall, in the Dalar river. These falls now all belong to the state, and the power calculations are subject to the requisite water regulations. The different power stations are intended to supply the following railway sections with power:

"The Karsefors station is to provide power for all state railways south of Falkenberg and Stockaryd. The scheme also embraces a peat power station in the

province of Smaland, although the latter is not required for the present-day traffic. From the Karsefors station it is proposed to carry power lines to Laholm and Ousby.

"The Trollhättan station will supply power to the Falkenberg-Gothenburg-Laxa line, the Falköping-Nässjö and the Sköfde-Karlsborg line; power wires will be carried to Gothenburg and Falköping.

"The Motala station will provide power for the Stockaryd-Gnesta and the Mjölby-Hallsberg line; power lines are to be carried to Linköping and Karlsby.

"The Hammarby Fall station will supply power to the Laxa-Katrineholm and the Hallsberg-Frövi line, with a power line to Ervalla. It is proposed to construct an auxiliary peat power station for the last two stations in the vicinity of Katrineholm, but this will not be required until 1920.

"The Alfkarleby Fall is intended for the Gnesta-Stockholm-Bollnäs section, and the Krylbo-Frövi line, besides the Kilafors-Stugsund line, by means of power lines to Storvik and Upsala. A special power line will be carried between Potebro and Saltskog, so as to obtain a direct high-tension connection without having to take it through Stockholm."

The report goes into particulars as to the bases on which the estimates of cost of installation and operation were made. All possible factors were taken into account and full allowance was made for depreciation and unavoidable waste. The results of the elaborate computations are given in the following tables:

"The aggregate cost, based upon the traffic of the year 1905 amounts to

	£
Electric lines, transformer stations, &c.	2,070,000
Power-stations	1,330,000
Total	3,400,000

"With 60 per cent. larger traffic, which is expected by the year 1920, the figures will be:—

	£
Electric lines, transformer stations, &c.	2,610,000
Power-stations	1,540,000
Total	4,150,000

"The expenditure, based on the traffic of the year 1905, amounts to:—

	£
On electric lines, transformer stations, staff of men, &c.	152,000
At power-stations	126,000
Management	5,500
Total	283,500

"The annual expenditure, based on an increase of 60 per cent. in traffic, as expected in 1920, amounts to:—

	£
On electric lines, transformer stations, staff men, &c.	191,000
At the power-stations	157,900
Management	6,600
Total	355,500

In 1905, 480 steam locomotives of all classes were required to handle the traffic. It is expected that the number of electric locomotives required to handle the same traffic will be 385 and these can be built at an additional cost of £127,000. It is expected, however, that the existing steam locomotives will serve their time owing to the gradual progress of the electrification and the increased locomotive cost is put at 8 per cent. of the total difference of cost, or about £10,000. The following tables give the comparative figures:

"The calculated expenditure for electric locomotives embraces (for present traffic):

	£
45 express locomotives	212,000
260 passenger and goods locomotives	1,300,000
80 smaller locomotives	222,000
Total	1,734,000

"The cost of steam locomotives of the same actual capacity amounts to:—

	£
57 express locomotives	171,000
335 goods and passenger locomotives	1,247,000
88 smaller locomotives	189,000
Total	1,607,000

The probable savings of electric over steam traction are then discussed and the method of making the estimates explained. On the basis of the traffic for 1905, "the aggregate savings by the introduction of electric traction are assumed to be as under:—

	£
Fuel, cost	204,000
" transport	16,000
Interest on coal in stock	6,600
Lubricant, &c.	5,700
Repairs	41,000
Pay to locomotive staff	24,000
" pumpers, &c.	28,800
Pumping-stations, &c.	5,000
Total	331,100

Under the conditions expected in 1920, the annual saving is put at £82,000.

"The calculations and particulars set forth above only apply to the State Railways of Southern Sweden, but as northern Sweden is singularly rich in water power, and as the traffic also in those parts is likely materially to increase, it is probable that —if the soundness of the calculations be confirmed—electric traction will, in due course, be adopted for the greater portion of the Swedish State Railways. The line most likely to be the first transformed from steam to electric traction is the important Stockholm-Gutenburg line."

THE ENGINEERING INDEX

THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE

The following pages form a descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full title of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Accidents.

Blackfriars Bridge Accident. Gives the summing up of Dr. F. J. Waldo, at the inquest held. 3500 w. Engng—Dec. 20, 1907. No. 89259 A.

Bascule.

The Ringeplaat Bridge (De Ringeplaatbrug). A detailed description of an electrically - operated railway bascule bridge in Delft harbor. Ills. 3500 w. Ingenieur—Nov. 23, 1907. No. 88885 D.

Blackwell's Island.

The Erection of the Anchor Arms of the Blackwell's Island Bridge. Brief illustrated description. 2500 w. Eng Rec—Dec. 21, 1907. No. 89102.

Erection of the Manhattan Approach of the Blackwell's Island Bridge. Illustrated detailed description. 1600 w. Eng Rec—Dec. 28, 1907. No. 89205.

The Queen's Approach to the Blackwell's Island Bridge, New York. Illustrated detailed description of an approach

We supply copies of these articles. See page 878.

consisting chiefly of a steel viaduct with spans from about 56 to 166 ft. 4000 w. Eng Rec—Dec. 7, 1907. No. 88772.

Cantilever.

The New Bridge over the Rhine between Ruhrort and Homberg (Die neue Rheinbrücke zwischen Ruhrort und Homberg). An illustrated description of the design and construction. 1700 w. Serial. 1st part. Deutsche Bau—Nov. 9, 1907. No. 88841 B.

The Bridge over the Rhine between Ruhrort and Homberg (Die Strassenbrücke über den Rhein zwischen Ruhrort und Homberg). Julius Stanek. Illustrated description giving costs of construction and materials. 2500 w. Oest Wochenschr f d Oeffent Baudienst—Nov. 23, 1907. No. 88846 D.

See also Blackwell's Island, under BRIDGES.

Compression Members.

A Series of Failure Tests of Full-Size Compression Members, Made for the Pennsylvania Lines West of Pittsburg. C. P. Buchanan. A detailed report of compression tests on full size bridge members. Also editorial. Ills. 6500 w. Eng News—Dec. 26, 1907. No. 89150.

Concrete.

The Design and Construction of Concrete Arch Bridges of Moderate Span (Ein Vorschlag zur Ausführung und Berechnung von Betonbogenbrücken mittlerer Spannweite). Emil Heidecker. A mathematical discussion. Ills. 4400 w. Serial. 1st part. Oest Wochenschr f d Oeffent Baudienst—Nov. 9, 1907. No. 88845 D.

Hudson Memorial.

The Design for the Hudson Memorial Bridge; New York City. Editorial criticism of the design prepared by the Dept. of Bridges of New York City. 2200 w. Eng News—Dec. 19, 1907. No. 89093.

The Engineering Features of the Proposed Henry Hudson Memorial Bridge. Leon S. Moisseiff. A report to the Dept. of Bridges, New York. Detailed description. 4000 w. Eng Rec—Dec. 28, 1907. No. 89204.

Pontoon.

Pontoon-Bridges for Road-Traffic Over Rivers in the Darbhangah District, Bengal. Edward Golding Barton. Describes the construction of five pontoon-bridges. Ills. 2000 w. Inst of Civ Engrs—No. 3656. No. 89084 N.

Reinforced Concrete.

A Reinforced Concrete Arch. Howard C. Ford. Illustrates and describes the replacing of a steel highway bridge across Boulder Creek, Colo., by a 70-foot reinforced concrete arch, giving cost-data. 1200 w. Jour of Engng, Univ of Colo—No. 3. No. 89220 N.

See also Concrete, Hudson Memorial, and Viaducts, under BRIDGES.

Steel.

Vauxhall Bridge, 1906. William Charles Copperthwaite. Describes the old bridge and the new steel-arch structure, the construction work, etc. Ills. 10000 w. Inst of Civ Engrs—No. 3670. No. 89085 N.

The Marien Bridge over the Danube Canal at Vienna (Die Marienbrücke über den Wiener Donaukanal). Dr. Karl Rosenberg. Illustrated description of the design and construction of this steel-arch structure. 2000 w. Serial. 1st part. Zeitschr d Oest Ing u Arch Ver—Nov. 22, 1907. No. 88853 D.

See also Bascule, Blackwell's Island, Cantilever, Compression Members, and Viaducts, under BRIDGES; and Steel Stresses, under CONSTRUCTION.

Viaducts.

The Woodbury Viaduct. Brief illustrated description of a double-track steel viaduct of plate-girder spans on the Erie & Jersey R. R., crossing Bonney Brook. 1000 w. Eng Rec—Dec. 14, 1907. No. 89011.

Reinforced-Concrete Viaduct on the Richmond and Chesapeake Bay Railway, Richmond, Va. Illustrated detailed description of an unusual structure. 1200 w. Eng News—Dec. 12, 1907. No. 88944.

The Reinforced-Concrete Viaduct of the South Holland Electrical Railway Company at Rotterdam (De Spoorwegviaduct van Gewapend Beton der Zuid-Hollandsche Elektrische Spoorweg-Maatschappij te Rotterdam). A. J. A. Braak. Illustrated description of the design and construction. 5000 w. Ingenieur—Nov. 9, 1907. No. 88884 D.

CONSTRUCTION.

Beams.

New Special Structural Shapes. Concerning new steel beam sections, known as the Bethlehem beams. 1200 w. Ry Age—Nov. 29, 1907. No. 88673.

Tests of Reinforced Concrete Beams, Series of 1906. Arthur N. Talbot. A report of tests made on rectanguiar beams, methods, materials, etc. Ills. 6500 w. Univ of Ill—Bul. 14. No. 89224 N.

A New Method of Determining the Position of the Neutral Axis in Reinforced-Concrete Beams (Ein neues Verfahren zur Bestimmung der Lage der Neutralachse bei armierten Betonkörpern). Leo Blondek. A mathematical discussion. Ills. 2500 w. Zeitsch d Oest Ing u Arch Ver—Nov. 29, 1907. No. 88854 D.

Buildings.

See Reinforced Concrete and Steel Buildings, under CONSTRUCTION; and Lighthouses, under WATERWAYS AND HARBORS.

We supply copies of these articles. See page 878.

Caissons.

See Breakwaters, under WATERWAYS AND HARBORS.

Columns.

The Design of Latticed Metallic Columns (Sur le Calcul des Pièces Métalliques Chargées de Bout dont les Ames sont à Treillis). M. F. Chaudy. A mathematical paper. Ills. 2000 w. Mem Soc Ing Civ de France—Aug., 1907. No. 88806 G.

Concrete.

The Finish of Concrete Surfaces. M. C. Tuttle. Read before the Boston Soc. of Civ. Engrs. Gives methods of producing a variety of surface textures. 1600 w. Eng Rec—Dec. 28, 1907. No. 89210.

See also Tunnel Lining, under CONSTRUCTION; Cement, under MATERIALS; and Locks, under WATERWAYS AND HARBORS.

Drainage.

See Reclamation and Tunnels, under CONSTRUCTION; and Ditches and Reservoir Lining, under WATER SUPPLY.

Earth Pressures.

The Bracing of Trenches and Tunnels, with Practical Formulas for Earth Pressures. Discussion of J. C. Meem's paper. 10800 w. Pro Am Soc of Civ Engrs—Nov., 1907. No. 88757 E.

The Bracing of Trenches and Tunnels, with Practical Formulas for Earth Pressures. Continued discussion of paper by J. C. Meem. Ills. 7000 w. Pro Am Soc of Civ Engrs—Dec., 1907. No. 89227 E.

Excavation.

Method and Cost of Loading Dump Wagons from an Ingeniously Designed Hopper or Table. J. C. Black. Illustrates and describes methods and outfit used at Portland, Ore., in excavating for a business block. 1500 w. Engng-Con—Dec. 11, 1907. No. 88998.

Piles.

See same title, under WATERWAYS AND HARBORS.

Reclamation.

The Method and Cost of Surveying and Reclaiming Wet Farm Land. L. G. Hicks. Paper read before the Illinois Soc. of Engrs. & Survs. describing a drainage system used in Nebraska. 3000 w. Engng-Con—Dec. 4, 1907. No. 88795.

Regulations.

New Reinforced Concrete Regulations in Philadelphia. A copy of the regulations of the Bureau of Building Inspection, approved Oct. 8, 1907. 3000 w. Cement—Nov., 1907. No. 89191 C.

Official Instructions Current in France for Reinforced-Concrete Construction (Instrucciones Oficiales Vigentes en Francia para el Empleo del Hormigón Armado). Ills. 10000 w. Revista Tech Indus—Oct., 1907. No. 88803 D.

Reinforced Concrete.

A Reinforced-Concrete Addition to a Brick Building. L. J. Mensch. Illustrated description of work in Salt Lake City, Utah. 1200 w. Eng News—Dec. 5, 1907. No. 88787.

A Reinforced Concrete Hotel Building in Oakland, Cal. Edw. L. Soule and John B. Leonard. Illustrated detailed description. 1500 w. Eng Rec—Dec. 21, 1907. No. 89107.

Personal Experiences with Reinforced Concrete. Observations, by E. P. Wells, on the report by the Committee of the Royal Institute of British Architects. 2800 w. Am Archt—Dec. 7, 1907. No. 88727.

Concrete Construction at Jamestown. Percy H. Wilson. Illustrated descriptions of the Government Pier and History Building, built mainly of reinforced concrete. 2000 w. Cement Age—Dec., 1907. No. 89190.

See also Beams, Regulations, Retaining Walls, Roofs and Stacks, under CONSTRUCTION; Reinforced Concrete, under MATERIALS OF CONSTRUCTION; Sewers, under MUNICIPAL; Lighthouses, under WATERWAYS AND HARBORS; and Car Houses and Subway Stations, under STREET AND ELECTRIC RAILWAYS.

Retaining Walls.

Retaining Walls on the Delaware, Lackawanna & Western R. R. at Buffalo. Brief illustrated description of reinforced concrete walls for track elevation work. 1200 w. Eng Rec—Dec. 21, 1907. No. 89103.

Rivets.

See same title, under MECHANICAL ENGINEERING, MEASUREMENT.

Roofs.

A Light Roof Girder System in a Reinforced Concrete Garage. Critical discussion of the design used for a garage at Sea Gate, Coney Island, in New York City. Ills. 3000 w. Eng News—Dec. 12, 1907. No. 88946.

The Design of 75-ft. Reinforced-Concrete Girders for the Mammoth Garage, White Plains, N. Y. C. E. Tirrell. Illustrated description of the most important points in the design of girders for a long-span roof. 4000 w. Eng News—Dec. 12, 1907. No. 88947.

Stacks.

The Design of Power Plant Chimneys. Frank Kingsley. Discusses methods of stack design, and reports investigations made, and effects of stated conditions. 5500 w. Eng Rec—Dec. 21, 1907. No. 89106.

Reinforced Concrete Chimneys. Abstract of a report of investigation made for the Assn. of Am. Portland Cement Mfrs. by Sanford E. Thompson. Gives

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general conclusions, requirements of design and construction, etc. 3300 w. Eng Rec—Dec. 28, 1907. No. 89208.

Steel Buildings.

Two New Record-Breaking Office Buildings in New York City. Illustrated detailed descriptions of the Singer Building, and of the City Investing Building. 3500 w. Eng News—Dec. 5, 1907. No. 88784.

See also Beams, Columns, and Steel Stresses, under CONSTRUCTION; Lighthouses, under WATERWAYS AND HARBORS; and Rivets, under MECHANICAL ENGINEERING, MEASUREMENT.

Steel Stresses.

Working-Stresses in Steel Construction. *C. A. P. Turner. Discusses points of general specifications when applied to structures of unusual size. 4000 w. Eng News—Dec. 12, 1907. No. 88945.

Tunnel Lining.

Method of Mixing and Placing Concrete for a Tunnel Lining. Illustrated account of work on the Burton tunnel of the Soutnern Ry., in Indiana. 1500 w. Engng-Con—Dec. 11, 1907. No. 88997.

Tunnels.

The Tunnel and River Shaft of the Detroit Water Works. James Ritchie. Descriptive account of the work. 2500 w. Jour Assn of Engng Socs—Nov., 1907. No. 88926 C.

Three Colorado Trans-Continental Tunnel Projects. George J. Bancroft. Describes mining, transportation and water diversion features. Ills. 1400 w. Min Sci—Dec. 19, 1907. No. 89111.

A New Highway Tunnel Under the Thames River at London, England. E. H. Tabor. Introductory review of the tunnels and bridges providing communication across the Thames, with illustrated detailed description of the Rotherhithe tunnel. 4000 w. Eng News—Dec. 19, 1907. No. 89089.

The Loetschberg Tunnel and Its Relation to Alpine Railway Routes. An account of a tunnel under construction which will give a new route to the Simplon tunnel. Also long editorial discussion on "The Commercial Aspects of Present and Proposed Alpine Railway Tunnels." Maps. 8500 w. Eng News—Dec. 5, 1907. No. 88786.

Repair Work in Tunnel (Travaux de Réparation de Tunnels). M. Siegler. Describes work on various tunnels of the Eastern Railway of France and valuable lessons which may be learned from the faults disclosed. Ills. 8000 w. Rev Gen d Chemins de Fer—Nov., 1907. No. 88877 G.

See also Earth Pressures, and Tunnel Lining, under CONSTRUCTION.

MATERIALS OF CONSTRUCTION.

Brick.

Frost Resistance of Brick. George E. Walsh. On the importance of securing quality in bricks for certain uses, the tests made and the results. 2500 w. Clay Rec—Nov. 15, 1907. No. 88641.

Cement.

Hydraulic Properties of Reground Cement Mortars. Henry S. Speckmand and Robert W. Lesley. Read before the Assn. of Am. Portland Cement Mfrs. Gives results of investigations. 2800 w. Eng Rec—Dec. 21, 1907. No. 89114.

Efficiency of Cement Joints in Joining Old Concrete to New. Concerning experiments reported by M. Mesnager, in *Ann. des Ponts et Chaus.*, showing the value of a cement wash in joining new concrete to old. 800 w. Eng News—Dec. 12, 1907. No. 88949.

Paints.

Preservation of Iron and Steel by Paint. Briefly considers means of protecting from exposures of various kinds. 2500 w. Met Work—Dec. 28, 1907. No. 89202.

Reinforced Concrete.

A Few Tests and Experiments with Reinforced Concrete. R. T. Surtees. An illustrated account of experiments carried out to determine the cause of the great difference found in work with this material. 3000 w. Eng Rec—Dec. 14, 1907. No. 89012.

Timber Decay.

Dry Rot in Timber. A discussion of the origin and cause, the prevention and cure. 1600 w. Builder—Nov. 23, 1907. No. 88695 A.

Timber Preservation.

Preservative Treatment of Poles by the Open-Tank Process. D. A. Rockwell. Describes the single- and double-tank methods, and plant requirements for the treatment. 2000 w. Elec Wld—Dec. 14, 1907. No. 89021.

See also Timber Decay, under MATERIALS OF CONSTRUCTION.

MEASUREMENT.

Mapping.

Sketch-Mapping, with Special Reference to Southern Nigeria. Lindow Hereward Leofric Huddart. Gives methods that have been found suitable under unfavorable conditions of ground and transport. 5500 w. Inst of Civ Engrs—No. 3634. No. 89083 N.

Surveying.

See Reclamation, under CONSTRUCTION; and Mapping, under MEASUREMENT.

Testing Materials.

See Compression Members, under BRIDGES.

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MUNICIPAL.

Garbage Disposal.

Municipal Refuse Disposal: An Investigation. J. T. Fetherston. Gives result of an investigation of local household refuse, with a series of tests in burning mixed wastes; and facts concerning a number of mixed refuse destructors. Ills. 14500 w. Pro Am Soc of Civ Engrs—Nov., 1907. No. 88755 E.

Pavements.

Improving Asphalt Pavements in Kansas City. E. A. Harper. Read before the Am. Soc. of Munic. Imp. An account of recent methods and tests made. 1200 w. Munic Engng—Dec., 1907. No. 89194 C.

Materials for Filling Joints of Brick Pavements. W. A. Howell. Read before the Am. Soc. of Munic. Imp. An account of methods in use in Newark, N. J. 1600 w. Munic Engng—Dec., 1907. No. 89193 C.

Repair Department.

The Construction and Repair Division of the City of Chicago. William D. Barber. Shows how this department has been organized and put upon a business basis. 4500 w. Eng News—Dec. 5, 1907. No. 88785.

Sewage Disposal.

Experimental Purification of Boston Sewage. Abstract of a paper by C. E. A. Winslow and E. B. Phelps, presented to the Boston Society of Civil Engineers. A study of local problems. 2200 w. Eng Rec—Nov. 30, 1907. No. 88662.

Sewage Disposal for Institutions and Small Communities. Theodore Horton. Paper before the Conference of N. Y. San. Officers. Considers domestic sewage and an installation that should obtain a sterile effluent suitable to be discharged into any stream. 3500 w. Munic Engng—Dec., 1907. No. 89192 C.

The Disposal of Domestic and Industrial Sewage and Rain Water at Gera (Häusliche Abwässer, Fabrikabwässer und Regenwässer in Gera). Herr Geissler. Describes the sewerage system of this Russian city of 47,000 inhabitants. 7000 w. Gesundheits-Ing—Nov. 2, 1907. No. 88862 D.

Sewers.

A Large Reinforced Concrete Sewer in the Borough of Queens, New York City. Illustrated detailed description of a circular trunk sewer under construction. 3000 w. Eng Rec—Nov. 30, 1907. No. 88659.

The Reconstruction of Large Sewers in St. Louis, Mo. Illustrates and describes methods used to increase the capacity of sewers. 1800 w. Eng Rec—Dec. 7, 1907. No. 88775.

The Harlem Creek Sewer, St. Louis, Mo. Information in regard to the construction of a reinforced-concrete sewer over a mile in length, and of large section. 1400 w. Eng Rec—Dec. 14, 1907. No. 89013.

Smoke Prevention.

Smoke Prevention in Cities. A late study of the problem at Syracuse, N. Y. 3000 w. Ir Age—Dec. 5, 1907. No. 88781.

The Solution of the Smoke Problem (Die Lösung der Rauchschaden-Frage). John H. Mehrtens. The first part of the serial is devoted to a review of past agitations and attempts for the abatement of the smoke nuisance in German cities. 5200 w. Serial. 1st part. Glasers Ann —Nov. 1, 1907. No. 88860 D.

Street Design.

Street Engineering. Rutger B. Green. Remarks on the need of supervision of street design, locations of pipes, sewers, etc., and suggestions of a system. 1800 w. Jour Assn of Engng Socs—Nov., 1907. No. 88927 C.

WATER SUPPLY.

Artesian Wells.

See Anticlinal Structure, under MINING AND METALLURGY, MISCELLANY.

Brisbane, Australia.

Brisbane and Its Water Supply. Allen Hazen. Describes conditions in Queensland, and the water supply of Brisbane, the intermittent filtration, and other features. Ills. 2500 w. Pro Am W-Wks Assn—1907. No. 88741 N.

Dams.

Raising a Dam at Lennep, Germany. Brief illustrated description of the raising of the crest of a dam to increase the capacity. 1600 w. Eng Rec—Dec. 28, 1907. No. 89209.

The Toxaway Dam. Milo S. Ketchum. Illustrated description of the construction of an earth dam for the creation of an artificial lake in North Carolina. 1500 w. Jour of Engng, Univ of Colo—No. 3. No. 89222 N.

The Munich Water-Power Plant at Moosburg on the Isar (Die Wasserkraftanlage der Stadt München bei Moosburg an der Isar). K. Dantscher. The first part of the serial describes the regimen of the river and the reinforced-concrete weir. Ills. Serial. 1st part. 2200 w. Beton u Eisen—Nov., 1907. No. 88865 F.

See also Reservoirs, under WATER SUPPLY; and Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Ditches.

Ditch Construction on the Seward Peninsula. Notes from a paper by James A. Kelly, before the Pacific N.-W. Soc.

of Engrs, describing the ditch of the Taylor Creek Ditch Co. 2000 w. Eng Rec—Dec. 7, 1907. No. 88773.

See also Reclamation, under CONSTRUCTION; and Reservoir Lining, under WATER SUPPLY.

Filtration.

Water Filter for South Norwalk, Conn. Illustrated detailed description of the plant. 1800 w. Munic Jour & Engr—Dec. 4, 1907. No. 88900.

The Care of a Mechanical Filter Plant. J. M. Diven. On the construction, coagulant feed, washing, sterilization, etc. Discussion. 4500 w. Pro Am W-Wks Assn—1907. No. 88734 N.

See also Brisbane, Australia, under WATER SUPPLY.

Fire Protection.

Fire Protection System of the American Dock Stores. Frank Sutton. Describes a dry pipe sprinkler system installed on Staten Island, N. Y. 2000 w. Eng Rec—Dec. 7, 1907. No. 88774.

Connections from Public Water Supply for Private Fire Protection Service. A. W. Hardy. Also Rates and Regulations at Atlanta, Ga., and at Elmira, N. Y. From papers, discussed together. 12000 w. Pro Am W-Wks Assn—1907. No. 88752 N.

Friction.

See Pipe Friction, under WATER SUPPLY.

Goldfield, Nev.

The Water Supply of Goldfield, Nevada. An illustrated account of the supply for this mining district in the center of a desert region. 2500 w. Eng Rec—Dec. 7, 1907. No. 88770.

Greeley, Colo.

A Gravity Water Supply System at Greeley, Col. An illustrated description of a system having various special features of arrangement and design. 6000 w. Eng Rec—Dec. 14, 1907. No. 89007.

Interchange.

Plan for Interchange Between Low and High Service Systems. Henry L. Lyon. Illustrated description of a "Manifold Valve System," designed by the writer to meet conditions at Buffalo, N. Y. Short discussion. 1200 w. Pro Am W-Wks Assn—1907. No. 88747 N.

Irrigation.

See Pumping Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Legislation.

Some notes on Rules, Ordinances and Court Rulings Governing the Operation of Water Plants. S. J. Rosamond. Concerning contracts, rules, free water, etc. 5000 w. Pro Am W-Wks Assn—1907. No. 88733 N.

London.

The Future Water Supply of London. Detailed discussion of the proposals which have been put forward. Also editorial. 3300 w. Engr, Lond—Nov. 29, 1907. Serial, 1st part. No. 88965 A.

Pipe Corrosion.

Note as to the Action of Water Upon Lead and Zinc. Dr. W. P. Mason. A discussion of the amount of metallic salts in solution that may be allowed with safety. 2200 w. Pro Am W-Wks Assn—1907. No. 88743 N.

Pipe Friction.

Loss of Pressure in Water Flowing Through Straight and Curved Pipes. Arthur William Brightmore. A record of experimental investigations carried out at the Royal Indian Engineering College, Cooper's Hill, which has now ceased to exist. 5500 w. Inst of Civ Engrs—..o. 3679. No. 89082 N.

Friction Coefficients for Water (Reibungscoefficienten für Wasser). Discusses the subject with reference to pipes, canals, etc. 3000 w. Serial, 1st part. Electrotech u Polytech Rundschau—Nov. 28, 1907. No. 88852 D.

See also Pipe Line Cleaning, under WATER SUPPLY.

Pipe Line Cleaning.

Tuberculation and the Flow of Water in Pipes. Nicholas S. Hill, Jr. Considers the deposits that lessen the carrying capacity of water pipes, the method of removing them, formulae for determining flow, etc. Also short paper on "Cleaning Water Mains," by Park Woodward, and discussion. Ills. 20000 w. Pro Am W-Wks Assn—1907. No. 88746 N.

Pipe Line Repairs.

Repairing a Broken Force Main. C. W. Wiles. Describes work at Delaware, Ohio. 800 w. Pro Am W-Wks Assn—1907. No. 88749 N.

Repairing Broken Submerged Pipe Line. Harry A. Lord. Brief account of work at Ogdensburg, N. Y. 1200 w. Pro Am W-Wks Assn—1907. No. 88750 N.

Pipe Lines.

Rifled Pipe Line for Conveying Oil on the Southern Pacific. Illustrated description of a line under construction in California for conveying crude oil. 2000 w. Ry Age—Dec. 13, 1907. No. 89002.

Remodeling of Discharge Pipes, Springfield Ave. Pumping Station, Chicago, Illinois. W. A. Levering and H. S. Baker. Illustrated description of the work, giving cost. 700 w. Pro Am W-Wks Assn—1907. No. 88748 N.

Pipe Lines for Hydraulic Power Plants. Abstract of a paper by Arthur Jobson, presented at meeting of the Telluride Institute. Discusses the methods of deter-

mining the most economical diameter of penstocks, loss of head in circular pipes, etc. 3000 w. Eng Rec—Dec. 21, 1907. No. 89104.

The High-Pressure Pipe Line and Power Station at Nordhausen (Die Hochdruckwasserleitung und das angeschlossene Kraftwerk der Stadt Nordhausen). Herr Michael. A pipe line 11 kilometers long with a total fall of 222 meters, and a hydro-electric station is illustrated and described. 4500 w. Zeitschr d Ver Deutscher Ing—Nov. 30, 1907. No. 88876 D.

Pitometer.

The Pitometer. Edward S. Cole. Explains the use of the portable pitometer for measuring the flow of water and facilitating the detection of waste. Ills. 4000 w. Jour Fr Inst—Dec., 1907. No. 88923 D.

The Pitometer and Water Works Losses. Edward S. Cole. Shows the extent of water waste and considers the remedy to be the use of a recording Pitot tube, which is illustrated and described. 3800 w. Pro Am W-Wks Assn—1907. No. 88735 N.

Pollution.

Peculiar Instance of Contamination of a Well Water. Dr. W. P. Mason. A brief account of a well at Wellingford, Conn., contaminated by gasoline. 800 w. Pro Am W-Wks Assn—1907. No. 88740 N.

Protection.

The Sanitary Protection of Surface Water Supplies. George A. Soper. Discusses measures available and rules. 2500 w. Pro Am W-Wks Assn—1907. No. 88753 N.

Pumping.

See under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Purification.

Laboratory Experiments in Water Treatment. Edward Bartow and J. M. Lindgren. An account of investigations made for remedying stated troubles. 3000 w. Pro Am W-Wks Assn—1907. No. 88754 N.

Notes on Water Purification at St. Louis. W. F. Monfort. A statement of the chemical and bacterial results for the past year, at one of the larger plants, using lime and iron sulphate as coagulants, without the use of filters. General discussion. 3000 w. Pro Am W-Wks Assn—1907. No. 88744 N.

The Best Method of Purifying Ground Water from Iron and Manganese (Ueber die besten Verfahren der Reinigung des Grundwassers von Eisen und Mangan). Heinrich Többen. 9000 w. Serial, 1st part. Gesundheits-Ing—Nov. 16, 1907. No. 88863 D.

See also Filtration, under WATER SUPPLY.

Reservoir Lining.

Lining Ditches and Reservoirs to Prevent Seepage Losses. Information from a bulletin (No. 188) issued by the University of California, concerning investigations and experiments with ditch linings, etc. 3500 w. Eng News—Dec. 5, 1907. No. 88789.

Reservoirs.

The Urft Dam and Hydro-Electric Power Distribution. Illustrated detailed description of this artificial lake, created in Rhenish, Prussia, to raise the low water level of the district, to prevent floods, and to supply electric light and power. 5500 w. Engng—Nov. 29, 1907. Serial, 1st part. No. 88961 A.

Stream Flow.

Flow of Water in Open Conduits. A. P. Merrill. Gives an outline of a thesis investigation, discussing the results. 3000 w. Eng Rec—Dec. 28, 1907. No. 89207.

Tunnels.

See same title, under CONSTRUCTION.

Water Meters.

Meters and Meter Systems. W. Volkhardt. Discusses the advantages of the meter system. 2200 w. Pro Am W-Wks Assn—1907. No. 88729 N.

The Cost of Meters at Rochester, N. Y. George W. Rafter. Reviews statistics of metered water in Rochester, comparing with other cities, especially in Europe. 5500 w. Pro Am W-Wks Assn—1907. No. 88730 N.

See also Pitometer, and Water Rates, under WATER SUPPLY.

Water Rates.

Rates for Water Service. Dabney H. Maury. President's address, outlining the principles which should govern the determination of a fair rate. 2000 w. Pro Am W-Wks Assn—1907. No. 88728 N.

Water Works Plants and the Proper Rates for Domestic and Public Service. John Ericson. Discusses methods of adjusting rates. 2000 w. Pro Am W-Wks Assn—1907. No. 88745 N.

Water Consumption, Waste and Meter Rates. James L. Tighe. Gives information concerning the city of Holyoke, Mass., as an example of the benefits of the meter system. 4000 w. Pro Am W-Wks Assn—1907. No. 88731 N.

Discussion of papers by Messrs. W. Volkhardt, George W. Rafter, and James L. Tighe. 6500 w. Pro Am W-Wks Assn—1907. No. 88732 N.

See also Water Meters, under WATER SUPPLY.

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Water Works.

Some Notes on Oriental Water Works. George A. Johnson. Brief account of features of water-works in Japan, India, China, and other Oriental countries. 5000 w. Pro Am W-Wks Assn—1907. No. 88742 N.

See also Pumping Engines and Pumping Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Water-Works Management.

Some Experiences in the Management of a Small Water Works. Howard Williams. 2500 w. Pro Am W-Wks Assn—1907. No. 88751 N.

WATERWAYS AND HARBORS.

Breakwaters.

The Port of Rosario (Puerto del Rosario). Dòmingo Carrique. An illustrated description of the rubble-stone masonry breakwater, its design and construction and particularly the building of the foundations in compressed air caissons. Serial, 1st part. 4000 w. Ingenieria—Oct. 30, 1907. No. 88805 D.

British Canals.

The Canal Inquiry. Discussing the evidence collected by the Royal Commission appointed to report on inland navigation of the United Kingdom, with the writer's views on this question. 3300 w. Elec Rev, Lond—Dec. 13, 1907. Serial, 1st part. No. 89131 A.

Coast Erosion.

The Royal Commission on Coast Erosion. A summary of the most important evidence from an engineering point of view. 4500 w. Engr, Lond—Dec. 20, 1907. Serial, 1st part. No. 89262 A.

Docks.

Notes on the Arrangements for Receiving Importations of Timber at Portishead Dock, Bristol. John William Hitchen. Discusses the considerations which led to the adoption of a particular method of dealing with timber, giving notes on the works constructed. 5000 w. Inst of Civ Engrs—No. 3672. No. 89081 N.

Dredges.

Sand-Pump Dredges for the Thames. Illustrated description of the twin-screw dredger, Lord Desborough. 500 w. Engr, Lond—Nov. 22, 1907. No. 88718 A.

Hydraulic Dredge Used on the New York State Barge Canal. Emile Low. Illustrated detailed description of the special dredge "Oneida." 1200 w. Eng News—Dec. 5, 1907. No. 88788.

Dredging.

The Method of Operating a Lobnitz Rock Cutter in Canal and Harbor Work. Lindon Bates, Jr. Illustrates and describes a machine to shatter submerged rock to a size capable of being handled by dipper dredges. 2500 w. Engng-Con—Dec 18, 1907. No. 89068.

Dry Docks.

Floating Dock at Rotterdam. Illustrated detailed description. 1400 w. Engr, Lond—Dec. 6, 1907. No. 89055 A.

Lighthouses.

The Construction of the Sanganeb Light House (Construction du Phare de Sanganeb). M. M. Charvaut. A description of the design and construction of this steel lighthouse on reinforced concrete foundations, recently built in the Red Sea. Ills. 6000 w. Mem Soc Ing Civ de France—Aug., 1907. No. 88807 G.

Locks.

Methods of Constructing Concrete Lock Walls by Means of Traveling Forms. Describes methods used near Boston for the lock through the Charles River dam. 700 w. Engng-Con—Dec. 4, 1907. No. 88794.

See also Mechanical Locks, under WATERWAYS AND HARBORS.

Mechanical Locks.

The Ship Lift on the Dortmund-Ems Canal. Illustrated description of the apparatus near Henrichenburg. 800 w. R R Gaz—Dec. 6, 1907. No. 88902.

The Oelhafen-Loehle Type of Lift Lock (Des Schiffshebewerk System Oelhafen-Loehle). K. E. Hilgard. Illustrated description of the mechanism. 2200 w. Schweiz Bau—Nov. 16, 1907. No. 88843 B.

Panama Canal.

Conditions Along the Panama Canal. Information from the recent annual report of the Commission, and the "Canal Record." Ills. 7800 w. Eng Rec—Nov. 30, 1907. No. 88657.

Panama Canal Progress. An illustrated account of the organization and division of work, accommodations, etc. 4500 w. Sci Am Sup—Dec. 7, 1907. No. 88791.

Isthmian Geology and the Panama Canal. Ernest Howe. An account based upon an official report of five months of field work. Examines dam and lock sites, materials of construction, etc. Ills. 7000 w. Ec-Geol—Oct., 1907. No. 89216 D.

Piers.

See Reinforced Concrete, under Construction.

Piles.

Diagrams to Determine the Bearing Power of Piles. G. F. Stickney. Gives instructions for facilitating work on the New York Barge Canal. By their use the safe load for any pile may be instantly determined. 600 w. Eng Rec—Dec. 28, 1907. No. 89211.

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Rio Grande.

Aggraded Terraces of the Rio Grande. Charles R. Keyes. Describes the remarkable terraced drainage-way. 2200 w. Am Jour of Sci—Dec., 1907. No. 89160 D.

Rock Dredging.

See Dredging, under WATERWAYS AND HARBORS.

Tiber.

Direct Communication Between Rome and the Sea and the Exposition of 1911 (La Comunicazione diretta fra Roma e il Mare e l'Esposizione del 1911). A. Brunelli. Discusses the importance of Italian commerce and the necessity of a navigable waterway from Rome to the sea, the cost and feasibility of the project, etc. 5500 w. Ann d Soc d Ing e d Arch Ital—Oct. 15, 1907. No. 88800 F.

U. S. Waterways.

Fifty Millions a Year for Waterway Improvements: Where Should It Be Spent? Editorial discussion of this question. 2300 w. Eng News—Dec. 12, 1907. No. 88948.

Wharf.

A Large Coal-Storage Wharf at Superior, Wisconsin. Illustrated detailed description of the construction and equipment of the wharf of the Berwind Fuel Co. 3000 w. Eng Rec—Nov. 30, 1907. No. 88661.

MISCELLANY.

Alaska.

Natural Conditions Affecting Engineering Work in Alaska. George B. Pillsbury. A brief account of the conditions to be expected on the Pacific Coast and in the interior. 1000 w. Eng News—Dec. 26, 1907. No. 89151.

Caisson Disease.

The Cause, Treatment and Prevention of the "Bends" as Observed in Caisson Disease. Prof. J. J. R. Macleod. Briefly describes the chief symptoms, discussing the cause, treatment, etc. 7000 w. Jour Assn of Engng Socs—Nov., 1907. No. 88925 C.

Earthquakes.

Construction to Withstand Earthquake Shocks (Edificacion contra Temblores). Domingo Selva. Discusses the stresses arising from earthquake shocks and the best means of building to withstand them, referring principally to small and medium-sized dwelling houses. Ills. 16000 w. Anal d l Soc Cien Argentina—July, 1907. No. 88804 N.

Slide Rule Computing.

Accuracy of Slide Rule Computations. John Berg. Gives results obtained and explains the convenience of its use. 1800 w. Eng Rec—Dec. 21, 1907. No. 89105.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable Laying.

See Cable Drawing, under TRANSMISSION; and Cable Ship, under MARINE AND NAVAL ENGINEERING.

Composite System.

A Composite Telegraph and Telephone System for Interurban Railways. Illustrates and describes a system on trial at Des Moines, Iowa. 2000 w. Elec Wld—Dec. 28, 1907. No. 89243.

Radio-Telegraphy.

The Poulsen Wireless Telegraph Station at Cullercoats. Describes a station where the Poulsen and spark methods are working side by side. Ills. 2500 w. Elect'n, Lond—Dec. 20, 1907. No. 89251 A.

A Directive System of Wireless Telegraphy. E. Bellini and A. Tosi. Describes some experiments carried out between three coast stations of the French Government. 3500 w. Elec Wld—Dec. 21, 1907. No. 89120.

Dr. Branly's Apparatus for Control of Distant Mechanical Effects. Illustrates and describes apparatus for controlling by radio-telegraphy the lighting of lamps, explosion of mines, sending up rockets, and various mechanical movements. 1200 w. Sci Am—Dec. 28, 1907. No. 89154.

Telautograph.

The Reproduction of Handwriting by Electricity. William Yale. Reviews the development of the telautograph, describing the instrument of George T. Tiffany. 1700 w. Yale Sci M—Dec., 1907. No. 89164 C.

Telegraph Lines.

Telegraph Construction in the German Colonies (Telegraphenbau in den deutschen Kolonien). Herr Hartung. Describes various features, poles, insulators, protective devices, etc., of telegraph line construction in the German colonies in Africa. Ills. 2500 w. Elektrotech Zeitschr—Nov. 14, 1907. No. 88880 D.

DISTRIBUTION.

See also under TRANSMISSION.

Current Rectifier.

Carborundum as a Rectifier for Electric Currents and Electric Oscillations. George W. Pierce. Abstract from *Phys. Rev.* Carborundum is shown to be unila-

terally conductive. 2000 w. Elect'n, Lond —Dec. 20, 1907. No. 89255 A.

Insulation.

Rubber Insulation for Conductors. Fred J. Hall. Gives general facts regarding rubber and information based on experience. 2500 w. Elec Wld—Nov. 23, 1907. Serial, 1st part. No. 88724.

Wiring.

Wiring for Direct Current and Alternating Current Motors. Louis J. Auerbacher. Directions with diagrams and information. 2000 w. Elec Wld—Dec. 7, 1907. No. 88910.

See also Illumination, under LIGHTING.

DYNAMOS AND MOTORS.

Air Gap.

The Reluctance of the Air-Gap in Dynamo Machines. T. F. Wall. Abstract of paper read before the Manchester Sec. of the Inst. of Elec. Engnrs. Describes the results of measurements made to ascertain the increase of the reluctance of the air-gap of a dynamo due to slotting the armature, and the distribution of the flux. 2500 w. Elect'n, Lond—Dec. 20, 1907. No. 89254 A.

Characteristic Curves.

A Simple Method of Deriving the Characteristic Curves of an Alternating-Current Machine (Eine einfache Herleitung der Betriebkurven einer Wechselstrommaschine). Hermann Zipp. A mathematical explanation of the method. Ills. 4000 w. Zeitschr d Ver Deutscher Ing—Nov. 2, 1907. No. 88868 D.

Coil Insulation.

Coil Insulation in Electrical Apparatus. Reviews the paper of J. A. Jacobs, presented at meeting of the Ohio Soc. of Mech., Elec., and Steam Engrs., which considers the three classes of insulation used in coils. 2000 w. Elec Wld—Dec. 7, 1907. No. 88908.

D. C. Dynamos.

The Influence of the Rated Speed and Output on the Design of Continuous-Current Generators. H. M. Hobart and A. G. Ellis. Gives data for 250 and 1000 kw. generators, with a number of designs for the same rated outputs at low and high speeds. 1500 w. Elec Rev., Lond—Dec. 20, 1907. Serial, 1st part. No. 89250 A.

D. C. Turbo-Generators.

The Development of Turbo-Generators. Dr. Robert Pohl. Discusses the difficulties in direct-current turbo-generator design, and describes a modified winding for direct-current machines which offers great advantages as regards increased output. 4000 w. Inst of Elec Engrs—Sept. 17, 1907. No. 88958 N.

Enclosed Motors.

The Heating of Enclosed Motors. A. G. Wessling. Argues that the enclosed type should only be used when absolutely necessary. 700 w. Sib Jour of Engng—Dec., 1907. No. 89201 C.

Induction Motors.

Leakage Coefficient of Induction Motors. R. E. Hellmund. Gives a formula possessing the requisite accuracy and giving good results. 1200 w. Elec Wld—Nov. 23, 1907. No. 88721.

The Leakage of Induction Motors. Dr. Rud. Goldschmidt. Aims to develop methods for the calculations of the no-load current and the leakage of three-phase, two-phase and single-phase motors, taking account of all influences as far as possible. 3000 w. Elect'n, Lond—Nov. 29, 1907. Serial, 1st part. No. 88977 A.

Single Phase Induction Motor Diagrams. Charles F. Smith. Gives the approximate construction of the Heyland diagram which is usually employed for commercial coil purposes, and also a diagram from which the performance of the motor may be studied under all conditions of loading. 2500 w. Mech Engr—Dec. 21, 1907. No. 89247 A.

See also Railway Motors, under DYNAMOS AND MOTORS.

Leakage.

See Induction Motors, under DYNAMOS AND MOTORS.

Railway Motors.

The Interpole Railway Motor. A Graphic Explanation. Norman G. Meade. 700 w. Elec Ry Rev—Dec. 28, 1907. No. 89231.

Single-Phase versus Continuous-Current Motors for Interurban Railway Service. Discusses the principal features of the single-phase railway motor, and indicates the lines along which future development of the continuous-current traction motor will proceed. 3500 w. Mech Engr —Dec. 7, 1907. No. 89035 A.

General Considerations of the Development and Possibilities of Single-Phase Motors for Railway Work. E. Heyland. Abstract of a lecture before the "Verband Deutscher Elektrotechniker." Describes simple single-phase induction motors supplied with slip-ring rotors, but without commutators, claiming superior results over commutator motors. 1500 w. Elect'n, Lond—Nov. 22, 1907. No. 88703 A.

See also Induction Motors, and Single-Phase, under DYNAMOS AND MOTORS.

Reluctance.

See Air Gap, under DYNAMOS AND MOTORS.

Repulsion Motors.

The Regulation of Repulsion Motors Through Lead of Brushes (Regelung von Repulsionsmotoren durch Bürstenver-

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schiebung). Karl Schnetzler. A theoretical and practical consideration of the method. Ills. Serial, 1st part. 2000 w. Elektrotech Zeitschr—Nov. 14, 1907. No. 88879 D.

Single Phase.

Recent Developments in Single-Phase Work for Power and Traction. V. E. Walters. Read before the Birmingham and District Elec. Club. Describes some of the recent developments in the single-phase motor, and its modern applications. 3500 w. Elec Engr, Lond—Dec. 20, 1907. No. 89249 A.

See also Induction Motors and Railway Motors, under DYNAMOS AND MOTORS.

Synchronous Motors.

Representation of Armature Reaction of the Synchronous Motor as an Equivalent Reactance. A. S. Langsdorf. Gives a proof of the accuracy of the simplifying assumptions, upon which all practical mathematical treatments of the phenomena of synchronous alternators have been based. 700 w. Elec Wld—Nov. 30, 1907. No. 88650.

Turbo-Generators.

See D. C. Turbo-Generators, under DYNAMOS AND MOTORS.

ELECTRO-CHEMISTRY.

Electro-Metallurgy.

The Manufacture of Glass by Electricity (Fabbricazione Elettrica del Vetro). Discusses the composition of various kinds of glass and the application of the electric furnace to their production. 3000 w. Serial, 1st part. Elettricita—Nov. 22, 1907. No. 88801 D.

See also same title, under MINING AND METALLURGY, IRON AND STEEL.

Electroplating.

A Simple Method of Depositing Metal Upon Glass, Wood, or Other Non-Metallic Substances. A description of the process. 1800 w. Brass Wld—Dec., 1907. No. 89185.

Nitric Acid.

Manufacture of Nitric Acid from the Air. Brief illustrated description of the Thomas and Barry process for the fixation of atmospheric nitrogen. 1000 w. Sci Am Sup—Dec. 21, 1907. No. 89063.

Nitric Acid from the Air. I. Moscicki, in *Elektrotechnische Zeit.* An account of the work of I. Moscicki and I. von Kowalski on the fixation of atmospheric nitrogen. Ills. 2500 w. Electro-Chem and Met Ind—Dec., 1907. No. 89059 C.

ELECTRO-PHYSICS.

Cells.

See Standard Cells, under ELECTRO-PHYSICS.

Coil Windings.

Multiple Wire Windings. Charles R Underhill. Discusses some conditions affecting the turns. 500 w. Elec Wld—Dec. 21, 1907. No. 89121.

Resistance.

The Variation of Resistances with Atmospheric Humidity. E. B. Rosa and H. D. Babcock. Discusses the variations in the values of manganin resistances, the causes of the changes, etc. 5000 w. Bul Bureau of Stand—Dec., 1907. No. 88931 N.

Resonance.

On Relative Resonance in Alternating-Current-Circuits (Ueber relative Resonanz im Wechselstrom-Kreis). F. Grünbaum. Discusses methematically and theoretically the influence of an iron core and the resistance in self-induction coils. Ills. Serial, 1st part. 4000 w. Elektrotech Zeitschr—Nov. 21, 1907. No. 88881 D.

Solenoids.

Characteristics of the Solenoid. Charles R. Underhill. A methematical study, giving curves of several solenoids of various lengths. 800 w. Elec Wld—Nov. 23, 1907. No. 88723.

The Influence of Frequency on the Resistance and Inductance of Solenoidal Coils. Louis Cohen. A report of investigations. 3000 w. Bul Bureau of Stand—Dec., 1907. No. 88932 N.

Standard Cells.

Clark and Weston Standard Cells. F. A. Wolf and C. E. Waters. Details and results of work done at the Bureau of Standards on their constancy and reproducibility. Ills. 20800 w. Bul Bureau of Stand—Dec., 1907. No. 88928 N.

The Electrode Equilibrium of the Standard Cell. F. A. Wolf and C. E. Waters. Describes results of a study of Clark and Weston cells. 1800 w. Bul Bureau of Stand—Dec., 1907. No. 88929 N.

GENERATING STATIONS.

Alternators.

See Parallel Operation, under GENERATING STATIONS.

Auxiliary Plants.

Steam Auxiliary to Hydro-Electric Station. William Lee Church. Aims to show that a steam auxiliary may, in certain cases, prove the largest earning factor. 1500 w. Elec Wld—Dec. 7, 1907. No. 88911.

Central Stations.

The Reconstruction of the Power System of the New Orleans Railway & Light Company. An illustrated account of consolidation and reconstruction. 7000 w. St Ry Jour—Dec. 7, 1907. No. 88762.

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Power Station of the Northern Colorado Power Company. Paul Affolter. Illustrated description of an electrical generating station at Lafayette, Colo. Ills. 2000 w. Jour of Engng, Univ of Colo—No. 3. No. 89223 N.

New Installations of the Electricity Supply Service of Brussels (Nouvelles Installations du Service de l'Electricité de la Ville de Bruxelles). Fernand Loewenthal. Detailed description of a new central station and transmission lines. Ills. 9000 w. Serial, 1st part. Soc Belge d Elec'ns—Nov., 1907. No. 88812 E.

See also Boiler Management, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Construction.

Cost of Constructing Steam-Driven Electric Power Plants. Frank Koester. Gives costs representing an average arrived at by a comparison of costs of various plants. 1700 w. Eng News—Dec. 19, 1907. No. 89090.

Design.

An Unwise Power Plant Layout and Some of the Results Entailed. H. R. Mason. Describes a trying case, the results, and the changes made. 1500 w. Power—Dec., 1907. No. 88994 C.

Hydro-Electric.

The Cost of Hydro-Electric Power Development in the Province of Ontario. A review of the reports of a study of present and future power conditions. 3500 w. Eng News—Dec. 19, 1907. No. 89091.

Rotating Screen of Power Canal, Salt River Project. F. Teichman. Illustration, with brief description. 600 w. Pro Am Soc of Civ Engrs—Nov., 1907. No. 88756 E.

The Tusciano Hydraulic Plant. C. L. Durand. Illustrated description of the principal features of a turbine station in Italy. 2000 w. Elec Rev, N Y—Nov. 30, 1907. No. 88648.

Hydro-Electric Generating Station on the Waipori River, in New Zealand. Illustrated description of the only high-tension transmission plant in Australasia. 5000 w. Elec Wld—Nov. 23, 1907. No. 88720.

Munaar Valley Electrical Power Scheme. Richard Fenwick Thorp. Detailed description of a plant to furnish power for the tea estates in India. 4500 w. Inst of Civ Engrs. No. 89078 N.

Electric Power Plants on Upper Missouri River. A. Floyd Bushnell. Illustrations, with brief description of a plant, the water for which is supplied by a steel dam at Hauser Lake, supplying current at 70,000 volts to Butte, Helena and Anaconda. 1000 w. Eng & Min Jour—Dec. 28, 1907. No. 89213.

The Water-Power Development of the Great Northern Power Co., near Duluth, Minn. Illustrated description of interesting development on the St. Louis River; especially the pressure regulating system at the Thomson, Minn., plant. 5000 w. Eng News—Dec. 26, 1907. No. 89152.

The Great Falls Power Plant of the Southern Power Company. L. T. Peck. Illustrated description of the power development on the Catawba River, which will furnish current for both Carolinas. 3500 w. Elec Jour—Dec., 1907. No. 89186.

Southern Water Power Developments. An account of development in the "Piedmont region," N. C., to furnish electric power for the driving of cotton mills. When completed it will be one of the largest power schemes in the world. Ills. 1600 w. Elec Wld—Dec. 28, 1907. No. 89240.

See also Auxiliary Plants, under GENERATING STATIONS; and Dams, Pipe Lines, and Reservoirs, under CIVIL ENGINEERING, WATER SUPPLY.

Isolated Plants.

See also Mechanical Plants. and Newspaper Plant, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Management.

Operating a Small Electric Plant. W. H. Wakeman. Suggestions for engineers of such plants. Ills. 2000 w. Elec Wld—Dec. 7, 1907. No. 88909.

Parallel Operation.

Notes on the Parallel Operation of Alternators. Waldo V. Lyon. Discusses the cause and effect of the interchange component of the armature current. 4500 w. Elec Wld—Dec. 28, 1907. No. 89241.

LIGHTING.

Arc Lamps.

Recent Progress in Flame Arc Lamps. A. Blondel. Discusses from a theoretical point of view the conditions necessary and those occurring in flame arcs. Also gives a comparison of the candle-power and prices of various systems of lighting. 3800 w. Elect'n, Lond—Dec. 20, 1907. No. 89253 A.

Electric Arc Lamps without Regulating Devices with Especial Reference to the Beck Lamp (Ueber elektrische Bogenlampen ohne Regulierwerk mit besonderer Berücksichtigung der Beck-Bogenlampe). Oskar Arendt. A general discussion. Ills. 4500 w. Elektrotech u Polytech Rundschau—Nov. 6, 1907. No. 88851 D.

See also Magnetite Arc, under LIGHTING.

We supply copies of these articles. See page 878.

Illumination.

Lighting of a Large Retail Store. Frederick J. Pearson. Illustrates and describes the lighting adopted by Marshall Field & Co. of Chicago, reporting tests made. 3500 w. Elec Rev, N Y—Dec. 7, 1907. No. 88906.

The Electric Illumination and Wiring of the New York Public Library. Charles Jenkins Spencer. Illustrated description of an important system now being installed in an imposing structure. 3000 w. Elec Age—Dec., 1907. No. 89118.

The Uniform Illumination of Horizontal Planes. Alfred A. Wohlauer. A theoretical discussion of the possibilities, with report of tests made. 2500 w. Elec Wld—Dec. 21, 1907. No. 89122.

Experimental Data on Illuminating Values. Clayton H. Sharp and Preston S. Millar. Condensed from paper read before the Assn. of Edison Ill. Cos. Deals with the various distributions given by a number of lighting arrangements. 3300 w. Elec Rev, N Y—Dec. 21, 1907. No. 89098.

See also Theatres, under LIGHTING.

Incandescent Lamps.

On the Determination of the Mean Horizontal Intensity of Incandescent Lamps. E. P. Hyde and F. E. Cady. Abstract from the Bul. of the Bureau of Standards. A report of investigations. 1800 w. Elect'n, Lond—Nov. 22, 1907. No. 88705 A.

A Comparative Study of Plain and Frosted Lamps. Edward P. Hyde and F. E. Cady. Describes the apparatus used and methods of study, discussing the results. 8800 w. Bul Bureau of Stand—Dec., 1907. No. 88930 N.

Metallic-Filament Lamps—How Will They Affect Electricity Undertakings. Argues the need of alterations in systems of connection and charging to meet the new conditions. 5000 w. Elec Engr, Lond—Dec. 6, 1907. No. 89038 A.

See also Tantalum Lamp, under LIGHTING.

Magnetite Arc.

Characteristics of the Magnetite Arc. G. M. Dyott. Gives results of some investigations with metallic arcs. 600 w. Elec Wld—Dec. 7, 1907. No. 88907.

Mercury Vapor.

A New Form of Cooper Hewitt Mercury Vapor Lamp. F. H. von Keller. Illustrated description of the new type, with other information. 3300 w. Jour Fr Inst—Dec., 1907. No. 88920 D.

Photometry.

The Problem of Color Photometry. J. S. Dow. A valuable résumé of this subject. Also editorial. 5500 w. Elec Wld—Nov. 30, 1907. No. 88651.

The International Photometric Commission (La Commission Internationale de Photométrie). M. F. Laporte. A report of the meeting held at Zurich in July, 1907. 4200 w. Bul Soc Inter d Elec'ns—Nov., 1907. No. 88813 F.

Street.

The City Lighting. Haydn Harrison. Reports results of a series of tests made in London to ascertain the value of the various means adopted in different parts of the city. 700 w. Elec Rev, Lond—Dec. 6, 1907. No. 89041 A.

Tantalum Lamp.

The Tantalum Lamp with High Resistance Filament. L. H. Walter. A brief account of investigations of the physical properties. 1200 w. Elect'n, Lond—Nov. 22, 1907. No. 88702 A.

Theatres.

The Electric Lighting of the Stuyvesant Theatre, New York City. Illustrated description of the elaborate equipment of a new theatre in West 44th St. 2000 w. Elec Rev, N Y—Dec. 21, 1907. No. 89097.

MEASUREMENT.

Alternator Testing.

The Determination of Load Resistance for Large Alternating-Current Generators (Die Berechnung der Belastungswiderstände für grosse Wechselstromgeneratoren). Carl Richter. A mathematical discussion and description of the water resistance method of testing. Ills. 4500 w. Elektrotech u Maschinenbau—Nov. 17, 1907. No. 88856 D.

Dynamo Testing.

Method of Testing Direct-Current Dynamos. E. S. Lincoln. Explains how to measure insulation resistance, locate connections and determine the rating and characteristics of a dynamo. 3000 w. Power—Dec., 1907. No. 88996 C.

Inductance.

On a Standard of Mutual Inductance. Albert Campbell. Abstract of a paper read before the Royal Soc. Considers the most suitable design for such a standard. 1400 w. Elect'n, Lond—Nov. 22, 1907. No. 88704 A.

Instruments.

Torque Analysis of Induction Meters. A. R. Dennington. A study of the production of the torque. 1200 w. Elec Wld—Dec. 21, 1907. No. 89124.

The Most Economical Shape of Winding for Electrical Measuring Instruments. A. P. Young. Gives a solution of a problem in the design proportion of electrical measuring instruments of the moving-coil type. 700 w. Elec Wld—Dec. 28, 1907. No. 89242.

Iron Losses.

Measurement of Iron Losses. Dr. J.

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Sahulka. Describes a method of rapidly determining the relation connecting the core loss per cycle with the frequency, giving results showing that loss increases with the frequency. 1000 w. Elect'n, Lond—Dec. 15, 1907. No. 89132 A.

Meters.

Some Recent Improvements in the Wright Mercury Electrolytic Meter. H. Stafford Hatfield. A short account of the later developments of this house service meter and the method of manufacture. 2800 w. Elect'n, Lond—Dec. 6, 1907. Serial. 1st part. No. 89043 A.

Meter Testing.

Notes on the Testing of Multi-Range Ammeters and Voltmeters and Low-Reading Voltmeters. A. E. Moore. Considers the best method of recording the readings, of expressing the accuracy or error of the instrument, etc. 2000 w. Elec Engr, Lond—Nov. 29, 1907. No. 88972 A.

Units.

Energy Transformations from the Electrical Engineers' Standpoint. H. M. Hobart. Advocates the general adoption of the kilowatt-hour as the unit of energy. The present number discusses the relation between heat and temperature. Also editorial. 2500 w. Elec Rev, N Y—Dec. 14, 1907. Serial. 1st part. No. 89019.

Wire Testing.

Commercial Testing of Wire and Cable. F. M. Farmer. Reviews the various tests made, describing methods. Ills. 5500 w. Elec Age—Dec., 1907. No. 89119.

TRANSMISSION.

See also under DISTRIBUTION and GENERATING STATIONS.

Alternating Current.

The Theory of Alternate Current Transmission in Cables. Explains the graphical method of dealing with circuits having resistance, capacity, and leakage, and gives the simplest possible mathematical treatment, leading to the employment of Dr. A. E. Kennelly's methods of calculation. 2500 w. Elect'n, Lond—Dec. 6, 1907. Serial. 1st part. No. 89042 A.

Balancing.

The Balancing of Multiple Wire Systems of Electrical Distribution. Prof. J. H. Dobson. A report of a study, made by the writer, of balancing in its various aspects. Chiefly directed to three-wire systems. 4500 w. Jour S African Assn of Engrs—Oct., 1907. No. 88696 F.

Cable Drawing.

Notes on Drawing-In Cables. W. Pleasance. Discusses cables drawn into pipes or ducts. 2200 w. Elec Rev, Lond—Nov. 29, 1907. No. 88976 A.

A Portable, Electrically-Driven Cable Reel (Eine fahrbare Kabelwinde mit elektrischen Antrieb). Herm. Schultz. An illustrated description of a wagon carrying a reel driven by an electric motor, the power for which is generated by a dynamo driven by a 6 horse-power benzine engine, used by the State Telegraph Department in Germany. 2000 w. Elektrotech Zeitschr—Nov. 28, 1907. No. 88882 D.

Cable Testing.

See Wire Testing, under MEASUREMENT.

Circuit Breakers.

Electrical Apparatus for High and Low Tension (L'Appareillage Electrique à Haute et Basse Tension). M. Vedovelli. Discusses principally circuit breakers and switchboards, noting the points to be observed in choosing and installing apparatus, and illustrating and describing types. Bul Soc Inter d Elec'ns—Nov., 1907. No. 88814 F.

Grounded Neutral.

Discussion on "The Grounded Neutral," at New York, October 11, 1907. 13500 w. Pro Am Inst of Elec Engrs—Dec., 1907. No. 88933 D.

Insulation.

See same title, under DISTRIBUTION.

Line Construction.

The Construction of Overhead Electric Transmission-Lines. Alexander Pelham Trotter. Deals mainly with the mechanical considerations of construction. Discussion. 26000 w. Inst of Civ Engrs—No. 3703. No. 89087 N.

Overhead Construction for High-Tension Electric Traction or Transmission. R. D. Coombs. Discusses the causes of interruption of service and how to guard against them; allowance for ice and wind loads; catenary stresses; and the requirements of construction. Ills. 7700 w. Pro Am Soc of Civ Engrs—Dec., 1907. No. 89225 E.

See also Telegraph Lines, under COMMUNICATION; and Wire Suspension, under STREET AND ELECTRIC RAILWAYS.

Line Design.

Long-Distance Power-Transmission Lines. Eric Adolf Löf. Shows the different factors to be taken into consideration for the proper design of the transmission line. 1000 w. Elec Rev, N Y—Nov. 30, 1907. Serial. 1st part. No. 88649.

Lines.

Joint Construction Pole Lines. H. B. Gear. Explains conditions in Chicago, and presents the advantages and disadvantages of joint lines. 2000 w. Cent Sta—Dec., 1907. No. 88799.

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See also Central Stations and Hydro-Electric, under GENERATING STATIONS.

Poles.

See Timber Preservation, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Regulations.

Governmental Regulations for the Distribution of Electrical Energy (Règlement d'Administration Publique sur les Distributions d'Energie). The provisions of the French decree which went into effect Oct. 26, 1907. 2500 w. Electricien —Nov. 9, 1907. No. 88818 D.

Transformers.

Abnormal Primary Current and Secondary Voltage on Placing a Transformer in Circuit. J. Murray Weed. An explanation of the results obtained by Messrs. Jensen and Andree, as recorded in the *Elec. Wld.* of Sept. 14. 2000 w. Elec Wld—Nov. 23, 1907. No. 88722.

Wire Suspension.

See same title, under STREET AND ELECTRIC RAILWAYS.

MISCELLANY.

History.

The Development of Electrical Technology (Der Werdegang der Elektrotechnik). F. Niethammer. A general review of the historical development of all branches of electrical science. 6500 w. Elektrotech u Maschinenbau—Nov. 3, 1907. No. 88855 D.

Kelvin.

The Late Lord Kelvin. An appreciative editorial review of his life and work. 9500 w. Engng—Dec. 20, 1907. No. 89261 A.

Lightning.

The Rolling of Thunder. D. S. Carpenter. Tends to show that rolling in thunder is due to the primary sounds of successive discharges. 1500 w. Elec Wld —Dec. 21, 1907. No. 89123.

Seismograph.

An Electrically Registering Seismograph (Séismograph à Enregistrement Electrique). R. Goldschmidt. Illustrated description. 2400 w. Soc Belge d Elec'ns —Nov., 1907. No. 88811 E.

INDUSTRIAL ECONOMY

Cost Systems.

A Uniform Cost System for Jobbing Foundries as Recommended by the Jobbing Founders' Association. James S. Stirling. Presented before the Philadelphia Foundrymen's Association, Dec. 4, 1907. 4500 w. Ir Age—Dec. 12, 1907. No. 88919.

Education.

Rational Trades Instruction. O. M. Becker. An illustrated article discussing the work of industrial schools. 5000 w. Cassier's Mag—Dec., 1907. No. 88979 B.

The Trade School Problems of Skilled Labor. C. Alfred Smith. Calls attention to facts and conditions in England. 2000 w. Elec Rev, Lond—Nov. 29, 1907. No. 88974 A.

The Royal Naval College at Greenwich, and the Training of Engineer Officers for the Royal Navy. J. W. W. Waghorn. An illustrated description of the buildings, and account of the training. 4000 w. Int Marine Engng—Jan., 1908. No. 89144 C.

Secondary Technical Education Applied to Mining. L. R. Young. Abstract of paper read at meeting of the Am. Min. Cong. 2000 w. Min Rept—Dec. 5, 1907. No. 88766.

The Mining Engineer (L'Ingénieur des Mines). M. Clément. An address on the work and education of mining engineers delivered at the Technical High School at Delft, Oct. 4, 1907. 3500 w. Ingenieur —Nov. 2, 1907. No. 88883 D.

Engineering Societies.

The Mechanical Engineer and the Function of the Engineering Society. F. R. Hutton. Presidential address. 16000 w. Pro Am Soc of Mech Engrs—Dec., 1907. No. 88759 C.

Exhibitions.

The Franco-British Exhibition of 1908. An illustrated account of structural features in progress for this great exhibition dedicated to science, art, and the industries of the two nations. 1400 w. Engng—Nov. 29, 1907. Serial. 1st part. No. 88960 A.

Gold Stock.

The Mechanical Management of the World's Stock of Gold. Alex. Del Mar. Gives a plan, suggested for increasing its mobility and service to commerce. 2500 w. Engineering Magazine—Jan., 1908. No. 89174 B.

Labor.

Why Good Workmen Are Scarce. Egbert P. Watson. Discusses some of the causes that tend to restrict the supply of skilled workmen. 2000 w. Cassier's Mag—Dec., 1907. No. 88980 B.

See also Education, under INDUSTRIAL ECONOMY.

Patents.

Reform of the Patent Law (Reform des Patentrechtes). Wolfgang Koch. Discusses changes necessary in the German

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Patent Law. 2500 w. Serial. 1st part. Zeitschr f Werkzeug—Nov. 15, 1907. No. 88850 D.

Salesmen.

The Functions of the Engineer as a Salesman. Sterling H. Bunnell. Shows that the fields of mechanics and business must overlap in engineering salesmen. 1600 w. Engineering Magazine—Jan., 1908. No. 89179 B.

Shop Management.

See Management, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Wages.

The Bonus System of Wages (Les Salaires à Primes). M. Paul Lecler. An elaborate discussion. Compares the bonus system with other systems of paying labor, describes the various developments of the system, the methods of operation, results, applications, etc. Ills. 20000 w. Mem Soc Ing Civ de France—Aug., 1907. No. 88808 G.

MARINE AND NAVAL ENGINEERING

Artillery.

Modern French Field-Guns. Illustrated detailed descriptions of the Schneider-Canet guns of the P. D. and of the P. R. patterns. Plate. 3500 w. Engng—Dec. 6, 1907. No. 89050 A.

Rifled Artillery. A. G. Greenhill. A theoretical investigation of the least amount of spin requisite for stability in flight of an elongated body through the air. 2500 w. Engr, Lond—Nov. 22, 1907. Serial. 1st part. No. 88716 A.

Some Comparisons Between French and English Artillery. Inaugural address of the President, M. Gustave Canet, delivered before the Junior Inst. of Engrs. 8500 w. Engng—Nov. 22, 1907. No. 88715 A.

Cable Ships.

A New Cable Ship. Frederick C. Coleman. Illustrated description of the "Guardian" and its machinery for laying submarine cables. 1200 w. Sci Am Sup —Dec. 14, 1907. No. 88953.

Destroyer.

H. M. Torpedo-Boat-Destroyer "Mohawk." Illustrated description of the vessel and its equipment with report of trial. 2500 w. Engng—Nov. 22, 1907. No. 88714 A.

Education.

See same title, under INDUSTRIAL ECONOMY.

Electric Power.

Modern Marine Transportation. William T. Donnelly. An illustrated article discussing the electric unit system of marine transportation. 2000 w. Int Marine Engng—Jan., 1908. Serial. 1st part. No. 89143 C.

Fishing Steamers.

The Principles of the Construction of Fishing Steamers (Die Grundlagen der Konstruktionsgleichungen für Fischdampfer). P. Knipping. A discussion of their design according to the kind of service for which they are intended. Ills. 2400 w. Serial. 1st part. Schiffbau—Nov. 13, 1907. No. 88844 D.

Mechanical Stoking.

See Locomotive Stokers, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Model Basin.

Simple Explanation of Model Basin Methods. An explanation of the work of an experimental model basin. 4000 w. Sci Am—Dec. 7, 1907. No. 88790.

Motor Boats.

The German Institution of Naval Architects. This first part gives a review of Dr. M. Bauer's paper on "High-speed Motor Boats." 1700 w. Engr, Lond—Nov. 29, 1907. Serial. 1st part. No. 88963 A.

The Motor-Yacht "Swietlana." Illustrated description of a vessel built in England for use on rivers in Central Russia. 800 w. Engng—Dec. 13, 1907. No. 89134 A.

See also Petroleum, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Resistance.

A Note on the Theory of Ship's Resistance (Beitrag zur Theorie des Schiffswiderstandes). H. Lorenz. A mathematical and theoretical discussion. Ills. 4500 w. Zeitschr d Ver Deutscher Ing—Nov. 16, 1907. No. 88872 D.

Ship Heating.

The Heating and Ventilating of Ships. Sydney F. Walker. The present article discusses the special requirements on board ship and the difficulties peculiar to ship work. 3500 w. Int Marine Engng —Jan., 1908. Serial. 1st part. No. 89142 C.

Steamboats.

Who Built the First Steamboat? C. Seymour Bullock. Gives a review of the work of a number of early mechanics and inventors, showing that the idea of ap-

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plying steam to the propulsion of vessels was in many minds about the same time. Ills. 6500 w. Cassier's Mag—Dec., 1907. No. 88984 B.

Steamships.

New Egyptian Mail Turbine Steamship Helopolis. Allan McPherson. Illustrated detailed description. 2000 w. Int Marine Engng—Jan., 1908. No. 89141 C.

Submarine Signalling.

Sound as a Means of Controlling Operations at a Distance. John Gardner. Describes a new method of automatically governing actions at a distance without solid connections. 2000 w. Elec Rev, Lond—Dec. 13, 1907. No. 89130 A.

Train Ferry.

The Proposed Channel Train-Ferry. Sir Nathaniel Barnaby. Briefly reviews the projects that have been suggested for railway connection across the English Channel, describing and discussing the train-ferry scheme. 2200 w. Westminster Rev—Dec., 1907. No. 89064 D.

Turbines.

See Steamships, under MARINE AND CANAL ENGINEERING.

U. S. Navy.

The American Fleet from an English Point of View. Archibald S. Hurd. Reviews the latest additions to the fleet and the programme for naval construction. Ills. 4000 w. Cassier's Mag—Dec., 1907. No. 88982 B.

MECHANICAL ENGINEERING

Ariel.

The 1908 Ariel Car. Illustrated description of this British vehicle. 500 w. Auto Jour—Dec. 7, 1907. Serial. 1st part. No. 89030 A.

Brakes.

Notes on Brakes. Edward T. Humphries. Briefly discusses foot, hand, and mechanical brakes. 1600 w. Autocar—Dec. 7, 1907. No. 89032 A.

Brake Testers.

An Electrical Brake Tester. Illustrated description of the Morris & Lister device. 900 w. Autocar—Dec. 21, 1907. No. 89245 A.

Buick.

The 18-H.P. and 24-H.P. Buick Petrol Cars. Illustrates and describes cars of American manufacture. 1800 w. Auto Jour—Dec. 14, 1907. Serial. 1st part. No. 89126 A.

Carburetting.

The Principles of Carburetting, as Determined by Exhaust Gas Analysis. Dugald Clerk. Read before the Incor. Inst. of Auto. Engrs. Describes the results obtained by the application of a new method to the study of perfect carburation. 5000 w. Autocar—Dec. 14, 1907. No. 89127 A.

Gas Analysis and Carburation. W. R. Ormandy and J. H. Lester. Shows that gas tests are as important as brake and consumption tests and how gas analysis may be used in connection with carburetter design. 4000 w. Autocar—Dec. 7, 1907. No. 89033 A.

Design.

Modern Motor Vehicles. Lt. Col. Rookes Evelyn Bell Crompton. Describes existing vehicles as examples of typical systems. General discussion. Ills. 41800 w. Inst of Civ Engrs—No. 3669. No. 89088 N.

Exhibitions.

Notes on the Recent Motor Show. A general review of the exhibition at Olympia. 4000 w. Engng—Dec. 6, 1907. No. 89049 A.

The Tenth Automobile and Cycle Exhibition (Le 10 Salon de l'Automobile et du Cycle). J. de Vergnes. A description of the exhibits at the recent show held under the auspices of the Automobile Club of France. Ills. Serial. 1st part. 3000 w. La Métallurgie—Nov. 20, 1907. No. 88823 D.

Farm Motor.

A Successful Farm Motor. C. M. Eason. An illustrated account of automobiles adapted to agriculture. 1500 w. Sci Am Sup—Dec. 7, 1907. No. 88793.

France.

The Automobile Situation in France. Jacques Boyer. Discusses the cause of the crash in automobile securities, and reviews the present status of automobile construction in France, with especial reference to the propelling machinery. Ills. 3500 w. Cassier's Mag—Dec., 1907. No. 88983 B.

The Automobile in France (Les Progrès de l'Automobilisme en France). P. Rimauce. Discusses the development of the industry, the growing use of the automobile, description of cars, costs, etc. Tables and curves. Ills. 4000 w. Serial. 1st part. Génie Civil—Nov. 23, 1906. No. 88827 D.

Fuels.

The Fuel System of Automobiles. Thomas J. Fay. Discusses details of the fuel question of interest to the user. 3500

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w. Automobile—Dec. 26, 1907. Serial. 1st part. No. 89168.

Garages.

The Electromobile Co.'s New Garage. Illustrated detailed description of a garage in London. 2500 w. Elec Rev, Lond—Nov. 29, 1907. No. 88973 A.

Modern Garage Plants (Moderne Garagen-Anlagen). Otto Rambuscheck. Gives suggestions for building small garages and illustrates and describes the arrangement of several large plants in Berlin. 2700 w. Zeitschr d Mit Motorwagen Ver—Nov. 30, 1907. No. 88886 D.

Gears.

The Jackson Epicyclic Gear for Cars, Cabs, Vans, and 'Buses. Illustrated description of a change-speed mechanism. 1800 w. Auto Jour—Dec. 14, 1907. Serial. 1st part. No. 89125 A.

Humphris System of Gear-Wheel Design. Illustrates and describes this mechanism. Also abstract of paper on "Gears and Gearing," by F. Humphris, read before the Royal A. C. 3800 w. Auto Jour—Dec. 21, 1907. Serial. 1st part. No. 89244 A.

Ignition.

The Relation Between Power and Spark. W. Watson. A comparison between accumulator and high tension magneto ignition. 2500 w. Autocar—Nov. 30, 1907. No. 88957 A.

See also Spark Coils, under AUTOMOBILES.

Lamps.

Automobile Lamps and Their Lenses. Victor Lougheed. Discusses the efficiency of a typical auto headlight, and matters related. Ills. 4000 w. Automobile—Dec. 12, 1907. No. 88917.

Motors.

Gasoline Engines for Automobiles. David Fergusson. A comparison of the four-cylinder and six-cylinder vertical types. Ills. 1700 w. Cassier's Mag—Dec., 1907. No. 88985 B.

It Costs More to Produce a Six Than a Four. F. B. Stearns. Discusses the relative merits. Also several short articles by different writers. 3700 w. Automobile—Dec. 19, 1907. No. 89096.

Omnibuses.

The Electrobus. An illustrated account of these vehicles, running in London, with details of the method of handling the accumulators, and the cost of running. 2000 w. Elect'n, Lond—Dec. 6, 1907. Serial. 1st part. No. 89044 A.

Pilgrim.

The "Pilgrim" Motor-Car. Illustrated detailed description. 1200 w. Engng—Dec. 6, 1907. No. 89051 A.

Progress.

Learned in the Process of Evolution. Charles B. Hayward. An illustrated description of poorly designed or poorly made parts and their improvement. 2500 w. Automobile—Dec. 5, 1907. No. 88796.

Six-Cylinder.

The Standard 20-H.P. Six-Cylinder Car. Illustrated detailed description. 1200 w. Autocar—Nov. 23, 1907. No. 88698 A.

Spark Coils.

The Design and Operation of Spark Coils. F. W. Springer. Discusses in detail the methods and effects of varying the various design factors of different coils, and the constructive and electrical characteristics of each kind of coil. 7000 w. Elec Wld—Dec. 14, 1907. No. 89020.

Speed Recorders.

Principles of Speed and Distance Recorders. Charles B. Hayward. An illustrated explanation of the working of these instruments. 3500 w. Automobile—Dec. 19, 1907. No. 89095.

Talbot.

The New 35-H.P. Talbot Car. Illustrated description. 700 w. Autocar—Nov. 30, 1907. Serial. 1st part. No. 88955 A.

Timing Device.

The Holden-Elphinstone Electric Timing Apparatus. Illustrated description of apparatus for timing cars. 1500 w. Auto Jour—Dec. 7, 1907. No. 89029 A.

White.

The 1908 White Steam Cars. Illustrates the new external thermostat and other improvements. 3000 w. Auto Jour—Nov. 23, 1907. No. 88697 A.

Wind Screens.

A Study of Wind Screens. Illustrates and describes various types. 1200 w. Autocar—Nov. 30, 1907. No. 88956 A.

COMBUSTION MOTORS.

Air Cooling.

Light Air-Cooled Internal-Combustion Motors (Les Moteurs Légers à Explosions avec Refroidissement par Circulation d'Air). M. J. Ambroise Farcot. Discusses various types but particularly the hot-air engine. Ills. 6000 w. Mem Soc Ing Civ de France—Sept., 1907. No. 88809 G.

By-Product Producers.

See Coking By-Products and Peat, under MINING AND METALLURGY, COAL AND COKE.

Exhaust Gas Analysis.

See Carburetting, under AUTOMOBILES; and Flue Gas Analysis, under STEAM ENGINEERING.

Gas Cleaning.

See Blast Furnace Gas, under MINING AND METALLURGY, IRON AND STEEL.

Gas Engines.

The Gas-Engine Cycle. W. H. Booth.

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Discusses the two-stroke and the four-stroke engine. 1600 w. Power—Dec., 1907. No. 88993 C.

The Cost of Depreciation. A. S. Atkinson. Discusses the question as related to gas engines. 2000 w. Engr, U S A—Dec. 2, 1907. No. 88688 C.

600-Horse-Power Two-Cycle Gas Engine. Illustrated description of an engine for driving a cotton spinning mill. 1800 w. Engr, Lond—Dec. 13, 1907. No. 89140 A.

Gas Power Plant at an Engineering Works. Illustrated description of a plant installed recently by Messrs. David Rowan & Co., Glasgow, for driving Marine Engine Works. 3300 w. Engr, Lond—Dec. 20, 1907. No. 89264 A.

The Evolution of the Internal Combustion Engine. S. A. Reeve. States the problem of the internal combustion engine in the light of past experience, and its solution. 16700 w. Pro Am Soc of Mech Engrs—Dec., 1907. No. 88758 C.

Novelties in Large Gas Engines (Nouveautés dans les Grosses Machines à Gaz). Herr von Handorff. Abstract translation of a paper in the *Zeitschr. d. Ver. Deutscher Ing.* for Aug. 14, 1907. Ills. 4000 w. Rev d Métal—Nov., 1907. No. 88817 E + F.

The Employment of Large Gas Engines in Germany (Notes sur L'Emploi des Grands Moteurs à Gaz en Allemagne). R.-E. Mathot. The extent of their use in Germany is discussed and some test results are given. 3000 w. Rev de Mécan—Nov. 30, 1907. No. 88890 E + F.

See also Gas Plant Testing, Ignition, and Thermal Efficiency, under COMBUSTION MOTORS; Refrigeration, under HEATING AND COOLING; Pumping Plants, under HYDRAULIC MACHINERY; Newspaper Plant, under POWER AND TRANSMISSION; Blast-Furnace Gas, under MINING AND METALLURGY, IRON AND STEEL; and Interurban, under STREET AND ELECTRIC RAILWAYS.

Gas Engine Wreck.

A Peculiar Gas Engine Wreck. A brief illustrated description of a wreck in a factory at Newark, N. J. 700 w. Power—Dec., 1907. No. 88991 C.

Gasoline.

See Motors, under AUTOMOBILES.

Gas Plant Testing.

Efficiency Tests of a Lignite-Gas Engine Generating Set (Abnahmeversuche an Braunkohlen-Grossgasdynamos). Report of a 1400 horse-power plant driven by two Nürnberg gas engines fed with gas from lignite briquettes. Ills. 1600 w. Elektrotech Zeitschr—Nov. 7, 1907. No. 88878 D.

See also Pumping Plants, under HYDRAULIC MACHINERY.

Gas Producers.

See also Gas Engines and Gas Plant Testing, under COMBUSTION MOTORS; Pumping Plants, under HYDRAULIC MACHINERY; and Coking By-Products and Peat, under MINING AND METALLURGY, COAL AND COKE.

Hot-Air Engine.

See Air Cooling, under COMBUSTION MOTORS.

Ignition.

A New Method of Working Internal-Combustion Engines. Describes a method recently devised by Messrs. Gebrüder Sulzer. 1200 w. Mech Engr—Dec. 21, 1907. No. 89248 A.

Oil Engines.

Oil-Motor for Agricultural Purposes. Illustrates and describes an agricultural oil-engine built in England. 2000 w. Engng—Nov. 29, 1907. No. 88962 A.

Petroleum Motors at the Kiel Motor-Boat Show (Petroleummotoren auf der Kieler-Motorbootausstellung). Herr Pflug. Illustrated description of the principal exhibits. 2200 w. Zeitschr d Mit Motorwagen Ver—Nov. 15, 1907. No. 88858 D.

Thermal Efficiency.

On the Limits of Thermal Efficiency in Internal Combustion Motors. Dugald Clerk. A report of investigations carried out by the Institution Committee. Also discussion. 17000 w. Inst of Civ Engrs—No. 3696. No. 89086 N.

HEATING AND COOLING.

Air Washers.

Air Washing and Humidifying and Some of Its Applications to Industrial Purposes. W. A. Rowe. Read before the Ohio Soc. of Mech., Elec., & Steam Engrs. The requirements and design of air washers are considered and their applications. 3500 w. Engr, U S A—Dec. 2, 1907. No. 88686 C.

Cooling Towers.

Cooling-Tower Practice. Dr. Jos. H. Hart. An illustrated review of the kinds of towers in use and some of the applications, working principles, and operation. 2000 w. Engineering Magazine—Jan., 1908. No. 89177 B.

Cooling Towers in Refrigerating Plants. B. Franklin Hart, Jr. Discusses types of cooling apparatus, and shows when cooling towers are available. 2500 w. Ice & Refrig—Dec., 1907. No. 89031 C.

Ice Making.

The Vacuum System of Ice Making. John Patten. A process for freezing water by its own vaporization in an almost complete vacuum. 3000 w. Ice & Refrig—Dec., 1907. No. 89025 C.

We supply copies of these articles. See page 878.

Industrial Buildings.

Modern Methods of Heating Industrial Buildings. E. Newton. A study of the conditions that make for workshop warmth and comfort. 2200 w. Wood Craft—Dec., 1907. No. 88640.

Plumbing.

Plumbing Work in the Washington Y. M. C. A. Building. A. R. McGonegal. Illustrated detailed description. 4500 w. Dom Engng—Dec. 28, 1907. No. 89228.

Radiation.

Data for a Heating Engineer's Handbook. Compiled by Gerard W. Stanton. Tables and explanatory notes. 1000 w. Heat & Vent Mag—Dec., 1907. Serial. 1st part. No. 89200.

Refrigeration.

Refrigeration and Power-Plant Practice. Joseph H. Hart. Shows the interrelations between the two. 2000 w. Elec Rev, N Y—Dec. 28, 1907. No. 89239.

Mechanical Production of Low Temperature. Sydney F. Walker. Explains why power is required and why heat is employed in refrigeration. 2500 w. Power —Dec., 1907. No. 88989 C.

Producer Gas in Refrigeration. Ellis L. Phillips. Some facts concerning the economy and reliability of gas power for use in refrigeration plants. Ills. 1700 w. Ice & Refrig—Dec., 1907. No. 89024 C.

Heat Transfer in Coolers and Condensers of the Double Pipe Type. R. L. Shipman. Gives results of recent theoretical and experimental investigations. 1800 w. Ice & Refrig—Dec. 6, 1907. No. 89036 C.

The Fish Freezing and Storage Plant of the Consolidated Weir Co., Provincetown, Mass. Howard S. Knowlton. Illustrated detailed description of a large fireproof fish-freezing warehouse and its equipment. 1600 w. Eng Rec—Dec. 28, 1907. No. 89206.

See also Cooling Towers, under HEATING AND COOLING; and Refrigeration, under RAILWAY ENGINEERING, TRAFFIC.

School House.

Heating and Ventilation of a School House. Charles L. Hubbard. Considers matters of detail, and treatment of special rooms in a typical city high school. Ills. 1800 w. Met Work—Nov. 30, 1907. No. 88642.

Valves.

See same title, under STEAM ENGINEERING.

Ventilation

Heating and Ventilating. George W. Nistle. A general review of present practice. 2200 w. Dom Engng—Dec. 21, 1907. No. 89094.

Important Differences Between Direct and Indirect Heating. R. S. Thompson. Discusses the proper ventilation of rooms heated by the two systems, showing that what is correct with one system is incorrect with the other. 2000 w. Met Work —Dec. 14, 1907. No. 88954.

Constructive Provisions for Preventing the Reversal of the Air Current in the Ground Floor, with Central Ventilating Plants (Konstructive Vorkehrungen zur Vermeidung der Umkehr des Luftstromes im Erdgeschoss bei zentralen Lüftungsanlagen). G. Recknagel. The first part of the serial gives a mathematical discussion of the subject. Ills. Serial. 1st part. 4500 w. Gesundheits-Ing—Nov. 30, 1907. No. 88864 D.

HYDRAULIC MACHINERY.

Accumulators.

The Design of Hydraulic Accumulators. N. S. Trustrum. Considers the design of the ram and cylinder, and other features of importance. 1300 w. Prac Engr—Nov. 29, 1907. No. 88968 A.

Centrifugal Pumps.

Centrifugal Pumps. E. F. Doty. Discusses the use of centrifugal vs. reciprocating pumps for domestic water supply. 2500 w. Engr, U S A—Dec. 2, 1907. No. 88689 C.

Centrifugal Pumps. E. F. Doty. Illustrates and describes their application for fire protection and condenser service. 2500 w. Engr, U S A—Dec. 16, 1907. No. 89062 C.

The Theory of Centrifugal Pumps and Fans (Zur Theorie der Zentrifugalpumpen und Ventilatoren). V. Blaess. A theoretical and mathematical paper on the principles of their design. Ills. 3000 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwessen—Nov. 9, 1907. No. 88848 D.

General Equations for Centrifugal Pumps (Allgemeine Gleichung für Zentrifugalpumpen). E. Busse. Discusses the general expression of the relation between head, speed of revolution, and quantity of water and the plotting of characteristic curves. Ills. 3000 w. Zeitschr f d Gesamte Turbinenwesen—Nov. 20, 1907. No. 88849 D.

See also Electric Pumping, under HYDRAULIC MACHINERY.

Dredges.

See same title, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Electric Pumping.

Electrically-Operated Pumping Plants. T. L. Kolkin. Considers the turbine pump, and the ram pump for this use. 1500 w. Elec Rev, Lond—Dec. 6, 1907. No. 89040 A.

Electrically Driven Centrifugal Pump, Buffalo, N. Y. Henry L. Lyon. Illus-

trated description of the electric pump, with comparison of cost with steam. Discussion. 4000 w. Pro Am W-Wks Assn—1907. No. 88738 N.

Pipe Friction.

The Friction of Oil in Pipes (Oelreibung in Röhren). R. Camerer. A record of elaborate experiments to determine the efficiency of automatic oil-pressure governors for water turbines. Ills. 3500 w. Zeitschr f d Gesamte Turbinenwesen—Nov. 9, 1907. No. 88847 D.

See also same title, under CIVIL ENGINEERING, WATER SUPPLY.

Pumping Engines.

Pumping-Engines and Pumps for the Kidderminster Water Supply. Illustrated detailed description. 800 w. Engng—Nov. 22, 1907. No. 88713 A.

High Duty vs. Low Duty Pumping Engines. Irving H. Reynolds. Calls attention to points of importance in making a decision between the two types. Discussion. 9500 w. Pro Am W-Wks Assn—1907. No. 88739 N.

Pumping Plants.

Pumping Water by Producer Gas Plant at St. Stephen, N. B. F. A. Barbour. States the conditions and describes in detail the gas producer plant adopted. 3800 w. Pro Am W-Wks Assn—1907. No. 88737 N.

Test of a Producer Gas Pumping Unit. C. H. Johnson and A. L. Sparrow. How tests were made of a producer-gas power plant and the results obtained. 1700 w. Engr, U S A—Dec. 2, 1907. No. 88687 C.

The Testing of Irrigation Pumping Plants. A report of field work in California to determine the actual cost of pumping water for irrigation by various methods and under various conditions. 3500 w. Eng News—Dec. 19, 1907. No. 89092.

Greater Economy in Small Pumping Plants. H. G. H. Tarr. Considers the coal consumption of steam pumps in relation to water-works plants, with suggestions for substituting the gas engine and producer gas. Discussion. Ills. 4500 w. Pro Am W-Wks Assn—1907. No. 88736 N.

Turbine Governing.

See Pipe Friction, under HYDRAULIC MACHINERY.

Water Wheels.

Tests of a 12-Inch Doble Water-Wheel. A. L. Westcott. Describes tests made by students of the University of Missouri. 700 w. Penn—Dec., 1907. No. 88995 C.

MACHINE ELEMENTS AND DESIGN.

Bearings.

Improvements and Novelties in Machine Parts (Maschinenteile. Fortschritte und Neuerungen). C. Volk. Illustrates and describes new types of bearings and couplings. 2200 w. Zeitschr d Ver Deutscher Ing—Nov. 9, 1907. No. 88869 D.

Cams.

Laying Out Automatic Screw-Machine Cams. F. E. Anthony. Illustrates and describes how the cams are laid out for operating the turret and cross slides. 3000 w. Am Mach—Vol. 30. No. 49. No. 88779.

Couplings.

See Bearings, under MACHINE ELEMENTS AND DESIGN.

Fly Wheels.

On Determining Size of Fly-Wheels for Motor-Driven Planers. W. Owen. Explains method of ascertaining the correct dimensions. 1000 w. Mach, N Y—Dec., 1907. No. 88693 C.

Gears.

Finding Change Gears by Prime-Factor Tables. John Parker. Gives a factor table from 1 to 10000, showing how change gears are calculated. 1500 w. Am Mach—Vol. 30. No. 49. No. 88777.

Tumbler Gear Design. John Edgar. Considers the faults of these gears, their design, etc. 2500 w. Mach, N. Y.—Dec., 1907. No. 88691 C.

See also same title, under AUTOMOBILES.

Rings.

Strength of Rings. An investigation showing the method of calculating the safe load. 1500 w. Engr, Lond—Dec. 20, 1907. No. 89263 A.

Roller Bearings.

Salient Principles of Roller Bearings. J. F. Springer. Discusses the practical differences between straight and tapered types, alinement of rollers, etc. Ills. 3000 w. Power—Dec., 1907. No. 88987 C.

Test of Bearings—Hyatt Roller vs. Babbitted. L. P. Alford. A comparative test which showed a saving in friction for the former. 1500 w. Am Mach—Vol. 30. No. 50. No. 88938.

MACHINE WORKS AND FOUNDRIES.

Boiler Making.

See Rivets, under MEASUREMENT; and Boiler Design and Boiler Repairs, under STEAM ENGINEERING.

Boring Machine.

Horizontal Turning and Boring Machine. Illustration with brief description, of a machine built in England for the Japanese Government. 500 w. Engng—Dec. 13, 1907. No. 89137 A.

Brass Founding.

The Brass Foundry. W. S. Quigley. Explains brass foundry conditions and discusses modern methods of melting and handling metal. Also discussion. 7500 w.

Pro N Y R R Club—Nov. 15, 1907. No. 89183.

Case Hardening.

See same title, under MINING AND METALLURGY, COPPER.

Castings.

Making Castings Off Broken Castings. Walter J. May. Directions for duplicating a broken casting where parts are missing. 800 w. Prac Engr—Dec. 6, 1907. No. 89034 A.

A Machine for the Production of Very Thin Castings. Illustrates and describes a new process for the casting of metals and alloys, invented by P. Bohin. 1400 w. Mech Engr—Nov. 30, 1907. No. 88970 A.

See also Phosphor-Bronze, under MATERIALS OF CONSTRUCTION.

Cost Keeping.

See Cost System, under INDUSTRIAL ECONOMY.

Cupolas.

See Foundry Fans, under MACHINE WORKS AND FOUNDRIES.

Cutting Tools.

See Tool Steels, under MATERIALS OF CONSTRUCTION.

Drilling.

Drill Heads for Closely Spaced Holes. Illustrated description of the mechanism of the Langelier Mfg. Co. to drive any number of drills very close together. 1200 w. Am Mach—Vol. 30. No. 50. No. 88937.

Drilling Machine.

A Precision Drilling and Reaming Machine. Illustrates and describes a machine for laying out and drilling work on a drill press so each piece will be an exact fit with many others. 1700 w. Am Mach—Vol. 30. No. 52. No. 89146.

Forging.

See Rolling, under MINING AND METALLURGY, IRON AND STEEL.

Foundry Costs.

See Cost System, under INDUSTRIAL ECONOMY.

Foundry Fans.

Blast for Cupolas. E. L. Rhead. Discusses fans, blowers and blowing engines, and air furnaces. Ills. 3000 w. Mech Engr—Nov. 30, 1907. No. 88969 A.

Foundry Practice.

See Brass Founding, under MACHINE WORKS AND FOUNDRIES.

Gear-Hubbing Machine.

A New British Gear-Hubbing Machine. I. W. Chubb. Illustrated detailed description. 1000 w. Am Mach—Vol. 30. No. 52. No. 89147.

Grinding Machines.

An English Universal Grinding Machine. J. E. Storey. Illustrates and describes a tool having interesting features of construction. 1800 w. Am Mach—Vol. 30. No. 52. No. 89148.

Machine Tools.

Interesting Operations in a Large Shop. Illustrates and describes machining with special tools, at the Westinghouse works. 1500 w. Am Mach—Vol. 30. No. 49. No. 88776.

Management.

General Arrangement of Manufacturing Buildings. Oscar E. Perrigo. Third of a series of articles on shop management and cost keeping. Ills. 2000 w. Ir Trd Rev—Dec. 5, 1907. No. 88798.

The Management of Production in a Great Factory. George F. Stratton. The first of a group of articles explaining the production methods of leading manufacturing plants in the United States. The present number deals with the General Electric Co.'s shops. 2500 w. Engineering Magazine—Jan., 1908. No. 89175 B.

See also Wages, under INDUSTRIAL ECONOMY.

Master Plates.

Master Plates and How They Are Made. E. M. King. An illustrated article describing accurate results obtained by using buttons and plugs and setting the plate by means of a sensitive test indicator. 3500 w. Am Mach—Vol 30. No. 51. No. 89069.

Microscope.

The Microscope in the Tool Room. F. A. Stanley. An illustrated article showing how a great variety of operations in connection with tool work may be facilitated by the use of the microscope. 4000 w. Am Mach—Vol. 30. No. 50. No. 88934.

Milling.

Locating Holes Accurately in Special Tools. J. G. Vincent. Describes exact work on the milling machine accomplished by verniers to check the distances. 1500 w. Am Mach—Vol. 30. No. 52. No. 89149.

Milling Machines.

Milling Machines. Illustrated detailed descriptions of types. 20000 w. Engr, Lond—Nov. 22, 1907. No. 88717 A.

Molding Machines.

Machine Molding for Cast-Iron Bathtubs (Moulage Mécanique des Baignoires en Fonte par le Système P. Dupont). H. Mamy. An illustrated description of the machine and process. 2500 w. Génie Civil—Nov. 2, 1907. No. 88824 D.

Pipe Manufacture.

The Manufacture of Cast Iron Pipe. W. B. Robinson. Illustrated description of the continuous process of making pipe, at Scottdale, Pa. 2000 w. Ir Trd Rev—Dec. 5, 1907. No. 88797.

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Pneumatic Tools.

Note on Pneumatic Striking Tools (Note sur les Frappeurs Pneumatiques). A. Baril. Illustrates and describes in detail several types of pneumatic chipping drills, riveters, etc., with a mathematical discussion of their operation. 9000 w. Rev de Mécan—Nov. 30, 1907. No. 88889 E +F.

Shop Heating.

See Industrial Buildings, under HEATING AND COOLING.

Shops.

The Avonside Engineering Works. Illustrated description of a new plant in Bristol, Eng. 1300 w. Engr, Lond—Dec. 20, 1907. No. 89268 A.

See also same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Soldering.

Some Soldering Appliances. Trans. from Edmund Schlosser's Das Löten. Illustrates and describes blowpipes, furnaces and other appliances. 4000 w. Sci Am Sup—Dec. 14, 1907. No. 88951.

Spindles.

A Method of Broaching Tang Slots in Spindles. John Edgar. Illustrated description of an ingenious method of obtaining the tang slot. 1000 w. Am Mach—Vol. 30. No. 51. No. 89071.

Woodworking Machines.

The Bearings of Wood-working Machines. W. J. Blackmar. Considers both upright spindle and horizontal bearings. 1800 w. Am Mach—Vol. 30. No. 51. No. 89072.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

Vanadium Steel. J. Kent Smith. States some of the attributes given steel by vanadium. General discussion. 5000 w. Pro Ry Club of Pittsburgh—Sept., 1907. No. 89161 C.

Heat Insulation.

A Laboratory Test for Heat-Insulating Materials. Charles R. Darling. Describes an apparatus for conducting reliable tests on small quantities of material. 1500 w. Engng—Dec. 6, 1907. No. 89053 A.

Phosphor-Bronze.

Some Notes on the Manufacture and Casting of Phosphor-Bronze. Erwin S. Sperry. Explains what phosphor-bronze is, its making, etc. 2500 w. Brass Wld—Dec., 1907. No. 89184.

Steel.

Hand Bending Tests. Capt. H. Riall Sankey. An account of tests made on eight types of steel experimented upon by the Alloys Research Committee, comparing the results with the tensile and other tests. 2000 w. Engng—Dec. 20, 1907. No. 89256 A.

Tool Steels.

The Theory of High Speed Tool Steel. George Auchy. Gives conclusions drawn from a comparison of authorities. 6000 w. Ir Age—Dec. 26, 1907. No. 89167.

A Comparison of the Productive Values of High-Speed Tool Steels and Carbon Steels. George Bilham. Examines cases illustrating the difference in productive values. 2500 w. Am Mach—Vol. 30. No. 50. No. 88935.

MEASUREMENT.

Extensometer.

A Method of Measuring the Extension of Test-Pieces under Tensile Stress. Wesley John Lambert. Describes an optical method of measuring the extensions. 700 w. Inst of Civ Engrs—No. 3694. No. 89080 N.

File Testing.

Testing the Cutting Quality of Files. Edward G. Herbert. Illustrates and describes a testing machine, giving some results of tests made with ordinary and special steels and correctly shaped teeth. 2000 w. Am Mach—Vol. 30. No. 51. No. 89073.

Pyrometry.

Measuring Industrial Temperatures. Thomas T. Read. Illustrates and describes types of pyrometers. 3500 w. Min & Sci Pr—Dec. 7, 1907. No. 89005.

Rivets.

An Investigation of the Influence of Some of the Commoner Defects in Riveted Work Upon the Strength of Joints. J. C. Black. Reports tests made to demonstrate the effect of certain features of riveted work commonly considered defects. 3000 w. Cal Jour of Tech—Nov., 1907. No. 89189.

Speed Indicators.

Some Speed Indicators (Quelques Indicateurs de Vitesse). A large number of types are described and their mechanism illustrated in detail. 7500 w. Rev de Mécan—Nov. 30, 1907. No. 88891 E + F.

POWER AND TRANSMISSION.

Belts.

The Proper Care of Belts in the Shop. William H. Taylor. Suggestions with illustrated description of appliances to insure equal tension. 2500 w. Am Mach—Vol. 30. No. 49. No. 88778.

Compressed Air.

See same title, under MINING AND METALLURGY, MINING.

Electric Driving.

Electric Drive in Iron and Steel Mills. W. Edgar Reed. Discusses methods of equalizing loads. 2000 w. Elec Jour—Dec., 1907. No. 89187.

Characteristics of Electric Motors. Edwin H. Anderson. How the work to be

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done determines a motor's continuous and intermittent capacity and its design and rating. 2500 w. Am Mach—Vol. 30. No. 50. No. 88936.

Electrical Driving in a Cloth Factory. Details concerning a practical comparison between group driving and individual machine driving carried out in a German cloth factory. 900 w. Elec Rev, Lond—Nov. 29, 1907. No. 88975 A.

The Electrical Equipment of the Workshops of the Buenos Ayres Western Railway Company at Liniers. Illustrated description of an installation for electric driving on the three-phase system at 440 volts. 5800 w. Elec Engr, Lond—Dec. 13, 1907. No. 89129 A.

Gas Power.

See Gas Engines and Gas Producers, under COMBUSTION MOTORS.

Lubrication.

Experiments with Graphite Lubrication. C. H. Benjamin. Gives results of tests showing that graphite improves the lubricating qualities of most oils. 2200 w. Am Mach—Vol. 30. No. 51. No. 89070.

Friction and Lubrication. Dr. J. T. Nicholson. Aims to explain the phenomena of the resistance offered to the relative motion of lubricated surfaces, in particular of journals and bearings. Describes modern methods of automatic and forced lubrication. 3000 w. Mech Engr—Nov. 30, 1907. Serial. 1st part. No. 88971 A.

Mechanical Plants.

New Mechanical Equipment of the Enlarged Tribune Building, New York. Illustrated description of the new layout for this 20-story office building. 4500 w. Eng Rec—Nov. 30, 1907. No. 88660.

Mechanical Plant of the Brooklyn Institute Building. Outlines the large extensions recently completed and gives an illustrated description of the power plant. 4500 w. Eng Rec—Dec. 14, 1907. Serial. 1st part. No. 89009.

The Power Plant of the Commercial National Bank Building. Illustrated description of a Chicago building plant with fire-tube boilers, vertical compound generating units and Corliss pumping engines. 2500 w. Engr, U S A—Dec. 2, 1907. No. 88685 C.

See also Newspaper Plant, under POWER AND TRANSMISSION.

Newspaper Plant.

The Mechanical Plant of the Boston Herald. Howard S. Knowlton. Illustrated description of the gas-engine driven generating station and electric driving of machines. 2500 w. Eng Rec—Nov. 30, 1907. No. 88658.

STEAM ENGINEERING.

Boiler Design.

Design of Riveted Joints for High-Pressure Boilers. Vernon Smith. Discusses the best and cheapest type of joint for any boiler. Ills. 1800 w. Prac Engr—Dec. 13, 1907. No. 89128 A.

Boiler Explosions.

The Greenwich Boiler Explosion. A report of evidence brought forward in a Board of Trade inquiry. 2000 w. Engr, Lond—Dec. 20, 1907. No. 89266 A.

Boiler Management.

Decree Regulating the Management of Steam Boilers (Décret Régulating l'Emploi des Générateurs à Vapeur). The text of the new French law. 3500 w. Serial. 1st part. Electricien—Nov. 30, 1907. No. 88821 D.

Fuel Economy in Central Stations (Les Economies de Combustible dans les Stations Centrales). J. Izart. Discusses means of attaining greatest economy in fuel consumption, as a commentary on a table showing the coal consumption per kilowatt in several large generating stations in England. 3500 w. Serial. 1st part. Electricien—Nov. 9, 1907. No. 88819 D.

See also Plant Management, under STEAM ENGINEERING.

Boiler Repairs.

Renewing Tubes in a Horizontal Tabular Boiler. J. E. Sexton. Describes the method employed and the tools required. 800 w. Power—Dec., 1907. No. 88988 C.

Boilers.

Grille Water-Tube Boilers at the Bordeaux Exhibition. Illustrates and describes a Grille boiler of the new type, giving an account of the working. 2000 w. Engng—Dec. 13, 1907. No. 89135 A.

Cooling Towers.

See same title, under HEATING AND COOLING.

Engine Foundations.

Erecting Machinery Foundations. J. A. Pratt. The characteristics of materials used are discussed and the construction methods. Ills. 2500 w. Mach, N Y—Dec., 1907. No. 88694 C.

Engine Governing.

An Investigation of Indirect Steam Engine Governing (Untersuchung einer Miltelbaren Dampfmaschinenregelung). W. Gensecke. Discusses hydraulic governing, the first part of the serial from a theoretical standpoint. Ills. Serial. 1st part. 3500 w. Zeitschr d Ver Deutscher Ing—Nov. 16, 1907. No. 88871 D.

See also Hoisting Engines, under MINING AND METALLURGY, MINING.

Engines.

A Portable Engine with Superheater. Illustrated description of a single-cylinder engine developing about 25 h.p. at 200 revolutions. 1500 w. Engr, Lond—Dec. 6, 1907. No. 89054 A.

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See also Pumping Engines, under HYDRAULIC MACHINERY; Auxiliary Plants and Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS; and Hoisting Engines, under MINING AND METALLURGY, MINING.

Entropy Diagram.

Application of the Entropy Diagram. Prof. Sidney A. Reeve. Its use made plain in computing any kind of action in or upon steam. 4000 w. Power—Dec., 1907. No. 88992 C.

Flue-Gas Analysis.

The Analysis of Flue and Exhaust Gases. Arnold Hartley Gibson. Shows how the accuracy of the analysis may be tested, and what interpretation should be put on the results obtained. 3000 w. Inst of Civ Engrs—No. 3648. No. 89079 N.

Fuels.

Pulverized Coal and Its Industrial Applications. William D. Ennis. Second instalment of two articles reviewing this subject. The present number considers modes of firing and construction of the furnace. Ills. 2500 w. Engineering Magazine—Jan., 1908. No. 89176 B.

See also Fuel, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Heat Insulation.

See same title, under MATERIALS OF CONSTRUCTION.

Mechanical Stoking.

See Locomotive Stokers, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Plant Cost.

See Construction, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Plant Management.

Economc Considerations on the Management of Plant. William H. Patchell. Address of the President before the Association of Engineers-in-Charge. 4500 w. Engng—Nov. 22, 1907. No. 88712 A.

Plants.

See Pumping Plants, under HYDRAULIC MACHINERY; Mechanical Plants, under POWER AND TRANSMISSION; and Auxiliary Plants and Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Separators.

Value of Separators. T. E. O'Donnell. Explains why they are necessary for the economical operation of a steam plant. Ills. 2500 w. Engr, U S A—Dec. 16, 1907. No. 89061 C.

Smoke Prevention.

See same title, under CIVIL ENGINEERING, MUNICIPAL.

Speed Indicators.

See same title, under MEASUREMENT.

Stacks.

See same title, under CIVIL ENGINEERING, CONSTRUCTION.

Steam vs. Electricity.

See Centrifugal Pumps, under HYDRAULICS.

Superheating.

The Specific Heat of Superheated Steam. Prof. Carl C. Thomas. Gives results showing both true and mean specific heats. Describes apparatus and experiments. 7000 w. Pro Am Soc of Mech Engrs—Dec., 1907. No. 88760 C.

See also same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Thermodynamics.

A Theory of Heat Influence. John Batey. Abstract of a paper read before the Birmingham Assn. of Mech. Engrs. An explanation of heat effect, with arguments. 4500 w. Prac Engr—Dec. 20, 1907. No. 89246 A.

Turbines.

Practical Side of Steam-Turbine Operation. W. J. Kennedy. An illustrated article giving results of three years experience. 2000 w. Power—Dec., 1907. No. 88986 C.

Steam Turbines at the A. S. R. A. Convention. Reviews papers by Messrs. Chilton, Kruesi, and Bibbins on the latest turbine construction and performance. 9500 w. Power—Dec., 1907. No. 88990 C.

Design of a 400-Kilowatt Reaction Turbine. Henry F. Schmidt. Illustrates and describes a practical method utilizing simple mathematics. 2000 w. Engr, U S A—Dec. 16, 1907. No. 89060 C.

The Practical Proportioning of the Reaction Steam-Turbine. Examines the empirical rules used by many builders for determining the proportions necessary 3300 w. Engng—Dec. 13, 1907. No. 89133 A.

The Zvonicek Steam Turbine (Dampfturbine System J. Zvonicek). J. Zvonicek. An illustrated description. 2000 w. Elektrotech u Maschinenbau—Nov. 24, 1907. No. 88857 D.

The Operation and Efficiency of Steam Turbines (Fonctionnement et Rendement des Turbines à Vapeur). M. Hanocq. Discusses particularly the de Laval turbine. A mathematical paper. Ills. 5500 w. Bul Scien d l'Assn d Elèves d Ecoles Spéc—June, 1907. No. 88810 D.

See also Steamships, under MARINE AND NAVAL ENGINEERING; and Blowing Engines, under MINING AND METALLURGY, IRON AND STEEL.

Valves.

Advantages of the Double Disk Design

We supply copies of these articles. See page 878.

of Gate Valve. Carlisle Mason. Types of gate valves are described and their merits and defects discussed. 2500 w. Engr, U S A—Dec. 2, 1907. No. 88690 C.

TRANSPORTING AND CONVEYING.

Cableways.

Cableways. F. T. Rubridge. Illustrated detailed description of various types, discussing their advantages and disadvantages, and related information. 3500 w. Jour of Engng, Univ of Colo—No. 3. No. 89221 N.

Car Dumping.

Car Dumping Elevators (Elévateurs-Basculeurs pour Wagons). A short illustrated description of the construction and mechanism of a type built by the Société des Ateliers d'Augsbourg et de Nuremberg. 1400 w. Génie Civil—Nov. 30, 1907. No. 88828 D.

Coal Handling.

The Coal-Handling Apparatus of a Large Coke Oven Plant. Illustrated description of an installation of unusual magnitude and arrangement, at Solvay, Ill. 3500 w. Eng Rec—Dec. 28, 1907. No. 89203.

See also Wharf, under CIVIL ENGINEERING, WATERWAYS AND HARBORS; and Coke Drawing, under MINING AND METALLURGY, COAL AND COKE.

Cranes.

Design of Light Structural Jib Cranes. W. H. Butz. The methods of computing the stresses in the various members are considered. 2500 w. Mach, N Y—Dec., 1907. No. 88692 C.

See also Docks, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Elevators.

Discussion—A High-Speed Elevator. Discussion of Charles R. Pratt's paper. Ills. 6000 w. Pro Am Soc of Mech Engrs—Dec., 1907. No. 88761 C.

Haulage.

See same title, under MINING AND METALLURGY, MINING.

Hoisting.

See Electric Hoisting, under MINING AND METALLURGY, MINING.

Ore Handling.

See same title, under MINING AND METALLURGY, MINING; and Nickel, under MINING AND METALLURGY, MINOR MINERALS.

MISCELLANY.

Aeronautics.

Santos Dumont's Latest Aeroplane. Illustrated description. 1200 w. Sci Am—Dec. 14, 1907. No. 88950.

Military Airships. J. L. Bagg. Discusses the present development of these airships. 2000 w. Yale Sci M—Dec., 1907. No. 89165 C.

Die Making.

Die-Sinking and Engraving-Machines. Illustrated description of London built machines and their operation. 1000 w. Engng—Nov. 22, 1907. No. 88711 A.

MINING AND METALLURGY

COAL AND COKE.

Accidents.

Coal Mine Accidents; Their Causes and Prevention. Clarence Hall and Walter Snelling. Extract from Bul. No. 333 (1907) of the U. S. Geol. Surv. Reviews the accidents of 1906 in the United States and their causes, discussing means of prevention. 4000 w. Min Wld—Dec. 28, 1907. No. 89234.

Belgium.

See Electric Plants, under MINING.

Briquettes.

See Russia, under COAL AND COKE; and Gas Plant Testing, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Coke Drawing.

The Marmac Coke Drawing and Loading Machine. Illustrated description of an underdrawing machine, consisting of an extractor and conveyor. 1800 w. Ir Age—Dec. 26, 1907. No. 89166.

Coke Ovens.

The Koppers Coke Oven. Illustrated description of a by-product system introduced from Europe. 2500 w. Ir Age—Dec. 12, 1907. No. 88918.

Coking.

See also Colorado, under COAL AND COKE.

Coking By-Products.

Dr. Ostwald's Process for the Production of Nitric Acid and Nitrate of Ammonia from Ammoniacal Liquor, as Applied to the Gas and Coke-Oven Industries. F. D. Marshall. An introductory review of other methods, and a description of the process named. Ills. 3300 w. Ir & Coal Trds Rev—Dec. 20, 1907. No. 89269 A.

Colorado.

Coal Mining and Coke Making in the Trinidad, Colorado, District. Describes this district and its development. Ills. 4800 w. Eng Rec—Dec. 14, 1907. No. 89010.

We supply copies of these articles. See page 878.

Eastern United States.

Were the Appalachian and Eastern Interior Coal Fields Ever Connected? George H. Ashley. A study of this problem with statement of conclusions. 3000 w. Ec-Geol—Oct., 1907. No. 89217 D.

Explosion.

Disaster at Monongah Coal Mines Nos. 6 and 8. Floyd W. Parsons. An illustrated account of an explosion in W. Va., probably caused by a loaded trip of cars breaking away and severing a trolley wire. 1800 w. Eng & Min Jour—Dec. 14, 1907. No. 89017.

Handling.

See Coke Drawing, under COAL AND COKE; and Coal Handling, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Japan.

The Coal Mines of Kyushu, Japan. Report by W. B. Cunningham, student interpreter of the British Embassy at Tokio. Map. 2000 w. Min Jour—Nov. 23, 1907. Serial. 1st part. No. 88706 A.

Michigan.

Mining the Coal Measures of Michigan. Lee Fraser. Describes the deposits, which are worked chiefly by pick and shovel. Ills. 900 w. Eng & Min Jour—Nov. 30, 1907. No. 88655.

Mine Dust-Removal.

A Coal Mine Vacuum Cleaner Plant. Illustrated description. 1200 w. Ir & Coal Trds Rev—Nov. 20, 1907. No. 88966 A.

Montana.

The Operation of Coal Mines in Montana. Floyd W. Parsons. Illustrates and describes the coal operations, methods of preparation, mine equipment, etc. 2800 w. Eng & Min Jour—Dec. 7, 1907. No. 88915.

Peat.

The Utilization of Peat for Heating and the Direct Production of Power. Abstract of an address by Prof. Adolf Frank to the Society for the Development of German Moors, with remarks by Dr. N. Caro. 2000 w. Sci Am Sup—Dec. 7, 1907. No. 88792.

The Production of Power from Peat. T. Tomlinson. Opening address before the Dublin Loc. Sec. of the Inst. of Elec. Engrs. Considers a scheme of utilization in the gas producer with recovery of by-products. 2300 w. Elec Engr, Lond—Dec. 6, 1907. Serial. 1st part. No. 89039 A.

Pennsylvania.

The Anthracite Mines at Alden, Penn. M. S. Hachita. Illustrated description of plant, methods, average output, haulage cost, etc. 2500 w. Eng & Min Jour—Dec. 28, 1907. No. 89215.

Rescue Appliances.

Rescue Methods in the Wurm and Inde District (Das Rettungswesen im Wurm- und Inde-Revier). Prof. Stegemann. Describes appliances and methods in a central district organization. Ills. 2000 w. Glückauf—Nov. 16, 1907. No. 88839 D.

Russia.

Tests of Russian Coal and Briquettes. Gives results of tests made by the Russian Marine Department. 1000 w. Col Guard—Nov. 22, 1907. No. 88709 A.

Safety Lamps.

The Dangers of Fulminating Caps for Lighting Safety Lamps. G. Chesneau, in *Ann. des Mines.* Detailed account of experiments with fulmnating caps, and also with white phosphorus igniters. 2700 w. Col Guard—Dec. 6, 1907. No. 89048 A.

Weathering.

The Weathering of Coal. S. W. Parr, and N. D. Hamilton. Reports results of a series of tests, stating conclusions. 1300 w. Ec-Geol—Oct., 1907. No. 89219 D.

Wyoming.

Mining Anthracite Coal in the Wyoming Valley. M. S. Hachita. Describes methods used. Steel beams support the roof. Ills. 1800 w. Eng & Min Jour—Dec. 21, 1907. No. 89101.

COPPER.

Alloys.

Alloys of Cobalt and Copper (Sur les Alliages de Cobalt et de Cuivre). N. Konstantinow. A note on some recent researches. Ills. 2000 w. Rev. de Métal—Nov., 1907. No. 88815 E + F.

Blowing Engines.

See same title, under IRON AND STEEL.

British Columbia.

Mining in Western Canada. H. Mortimer Lamb. Describes conditions in the Yukon and coast districts, and other mining regions of British Columbia. Ills. 3500 w. Mines & Min—Dec., 1907. No. 88680 C.

Mining in the Rossland District, British Columbia. Ralph Stokes. The first of a series of illustrated articles describing the mines of this district, and the yield of copper, gold and silver. 2200 w. Min Wld—Dec. 21, 1907. Serial. 1st part. No. 89115.

California.

Recent Developments at Furnace Creek Copper Mines. Francis C. Nicholas. An account of present conditions at these mines in the Greenwater district of California. Ills. 1800 w. Min Wld—Dec. 21, 1907. No. 89117.

Case Hardening.

Face-Hardening Copper and Bronze. Walter J. May. Describes methods used by the writer. 700 w. Prac Engr—Nov. 22, 1907. No. 88699 A.

We supply copies of these articles. See page 878.

Chile.
The Braden Copper Mines in Chile. William Braden. Illustrated description of two mines in the Andes, the geological occurrence, system of mining, etc. 2500 w. Eng & Min Jour—Dec. 7, 1907. No. 88913.

The Paderosa Copper Mine of Callahuasi, Tarapacá, Chile. Robert Hawxhurst. Abstract translation from *El Nacional*. Descriptive. 1200 w. Min Jour—Nov. 23, 1907. No. 88707 A.

Lake Superior.
Mines of the Lake Superior Copper Region. Dwight E. Woodbridge. Describes geologic and mining features, mechanical innovations, and the present status of operations. 2500 w. Min Sci—Dec. 12, 1907. No. 89057.

North Carolina.
The Gold Hill Copper Mine, and Its Development. Francis C. Nicholas. An illustrated account of this gold-copper region in North Carolina. 1200 w. Min Wld—Dec. 7, 1907. No. 88916.

Shetland.
See same title, under IRON AND STEEL.

GOLD AND SILVER.

Assay Furnaces.
Construction and Manipulation of a Gasoline Assay-Furnace. Wilton E. Darrow. Gives drawing and description of a home-made furnace, with an account of the making of a control assay on sulphides. 1800 w. Min & Sci Pr—Dec. 14, 1907. No. 89066.

British Columbia.
See same title, under LEAD AND ZINC.

Cyanidation.
Cyanidation with the Brown Vat. Francisco Narvaez. Diagram and description. 900 w. Min & Sci Pr—Nov. 30, 1907. No. 88768.

Cyanide Filter.
The Burt Rapid Cyanide Filter. E. Burt. Illustrated description of a plant and its operation. 1500 w. Min & Sci Pr—Dec. 7, 1907. No. 89006.

Cyanide Tank.
The B. and M. Circulating-tank. F. C. Brown. General description of apparatus, method of working, etc., with diagrams. 3000 w. N Z Mines Rec—Oct. 16, 1907. No. 89157 B.

Dredging.
Modern Gold Dredging Practice and Equipment. Horace J. Clark. An illustrated discussion of the dredging of shallow bars and beds of rivers as a commercial possibility. 1000 w. Min Wld—Nov. 30, 1907. No. 88665.

Goldfield, Nev.
The Association of Alunite with Gold in the Goldfield District, Nevada. Frederick Leslie Ransome. Describes the close association of gold and alunite, giving a microscopic study of the rocks and discussing the origin of the deposits. Ills. 9000 w. Ec-Geol—Oct., 1907. No. 89-218 D.

See also same title, under CIVIL ENGINEERING, WATER SUPPLY.

Gold Production.
The Increased Gold Production and Its Effect Upon the Cost of Living. F. Lynwood Garrison. An analysis of the present production and its economic effects. 2000 w. Jour Fr Inst—Dec., 1907. No. 88922 D.

Gold Refining.
Gold Refining. Donald Clark. Deals with the processes for producing refined metal. 2500 w. Aust Min Stand—Oct. 30, 1907. Serial. 1st part. No. 89028 B.

History.
The History of Gold and Silver. James W. Malcolmson. A summary of the ancient and modern uses of the precious metals, the sources of supply, and the effect of supply on value. 3500 w. Eng & Min Jour—Nov. 30, 1907. No. 88654.

Mexico.
The Mines of Balanos, Old Mexico. Ernest E. Behr. History and description of these old silver mines and their production. 2500 w. Cal Jour of Tech—Nov., 1907. No. 89188.

Topographical and Other Notes on the Choix-Guadalupe y Calvo Mining Districts. A. W. Warwick. Map and description of these districts in Mexico. 3000 w. Min & Sci Pr—Nov. 30, 1907. No. 88767.

Nevada.
Mining Developments in Nevada. A. Selwyn-Brown. An estimate of conditions and prospects of gold production. 3800 w. Engineering Magazine—Jan., 1908. No. 89182 B.

See also Goldfield, Nev., under GOLD AND SILVER; Nevada, under LEAD AND ZINC; and Goldfield, Nev., under CIVIL ENGINEERING, WATER SUPPLY.

Placers.
See Drilling, under MINING.

Rand.
See Ore Handling, under MINING.

Roasting.
See Telluride Ores, under GOLD AND SILVER.

Telluride Ores.
The Roasting of Telluride Ores. R. L. Mack and G. H. Scibibd, with an introduction by T. T. Read. States the difficulties presented in the treatment of these gold-bearing ores, and describes experiments in roasting. 4000 w. Min & Sci Pr—Dec. 14, 1907. Serial. 1st part. No. 89067.

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IRON AND STEEL.

Assaying.

Assay of Iron. Symbol Fe. Atomic Weight 56. Evans W. Buskett. Gives the permanganate and the bichromate methods. 1200 w. Mines & Min—Dec., 1907. No. 88681 C.

Metals and Alloys. Abstract translation from *Rassegna Mineraria.* Describes the chief methods of analysis of alloys and ferro-alloys. 3300 w. Min Jour—Nov. 23, 1907. No. 88708 A.

See also Nickel Determination, under MINOR MINERALS.

Blast-Furnace Gas.

Blast Furnace Gas Cleaning Plants on the Zschocke System (Installations pour l'Epuration des Gaz de Hauts Fourneaux, Système Zschocke). M. Wolf. Illustrates and describes this system of gas cleaning and several of the more recent installations. 3500 w. Génie Civil—Nov. 16, 1907. No. 88825 D.

Blowing Engines.

A 750 Horse-Power Brown-Boveri-Rateau Turbo-Fan (Turbogebläse, Bauart Brown-Boveri-Rateau, von 750 PS). K. Rummel. Illustrated description of the design, giving results of operation, of this steam-turbine driven fan. 5000 w. Zeitschr d Ver Deutscher Ing—Nov. 23, 1907. No. 88873 D.

Electro-Metallurgy.

The Electro-Thermic Production of Iron and Steel. Joseph W. Richards. A review of the progress made in the electro-thermic metallurgy of iron, describing furnaces and methods, etc. Ills. 3000 w. Jour Fr Inst—Dec., 1907. Serial. 1st part. No. 88924 D.

The Electro-Metallurgy of Iron and Steel (L'Electrométallurgie du Fer et de l'Acier). A general review of methods, processes, products, etc. Serial. 1st part. 4000 w. Revue d'Electrochim et d'Electrométal—Oct., 1907. No. 88887 F.

The Desulphurization of Iron in the Kjellin Induction Furnace (Beitrag zur Entschweflung des Eisens im Kjellinschen Induktionsofen). A. Schmid. Gives the results of tests. 2000 w. Stahl u Eisen—Nov. 6, 1907. No. 88831 D.

The Röchling-Roderhauser Electric Induction Furnace (Der elektrische Induktionsofen nach dem System Röchling-Rodenhausen). H. Wedding. Illustrated detailed description of a new furnace at the Röchling steel works at Völklingen, Germany, with details of its operation. 4000 w. Stahl u Eisen—Nov. 6, 1907. No. 88830 D.

See also Steel Making, under IRON AND STEEL.

Forging.

See Rolling, under IRON AND STEEL.

History.

The Iron Making of Antiquity (Das Eisenhütten-wesen im Altertum). F. Freise. A discussion of the raw materials, smelting arrangements, blowing devices, processes and results in ancient iron smelting. Ills. 3500 w. Serial. 1st part. Stahl u Eisen—Nov. 6, 1907. No. 88832 D.

Rolling.

Forging and Rolling Mild Steel. Suggestions for successful treatment. 1200 w. Mech Engr—Nov. 23, 1907. No. 88700 A.

Rolling Mills.

Cartridge-Metal Rolling Mill. Illustrated description. 600 w. Engng—Dec. 20, 1907. No. 89260 A.

Segregation.

A Further Study of Segregation in Ingots. Henry M. Howe. Discusses the influence of ingot size; and the rate of cooling, in the degree of segregation in steel ingots. Also other questions bearing on the subject. 5000 w. Eng & Min Jour—Nov. 30, 1907. No. 88653.

Shetland.

Iron and Copper Mining in Shetland. Robert W. Dron. Read before the Geol. Soc. of Glasgow. An account of the mines and their limited development. 1500 w. Ir & Coal Trds Rev—Nov. 22, 1907. No. 88719 A.

Steel Making.

Qualitative Work in the Production of Steel and in Electric Smelting (Qualitative Arbeit in der Stahlerzeugung und elektrisches Schmelzverfahren). O. Thallner. A criticism of the methods of steel production with reference to their economy and especially considering electric smelting. 6300 w. Serial. 1st part. Stahl u Eisen—Nov. 20, 1907. No. 88834 D.

Steel Works.

The Friedrich-Alfred Iron and Steel Works, Rheinhausen. Illustrated detailed description of this plant of the Krupp firm. 3500 w. Ir & Coal Trds Rev—Nov. 29, 1907. No. 88967 A.

The Witkowitz Company, Moravia, Austria-Hungary. G. B. Waterhouse. History and illustrated description of these iron and steel works. 2300 w. Ir Age—Dec. 5, 1907. No. 88780.

Recent Austrian Steel Works (Neues in Oesterreichischen Eisenhüttenwerken). Theodor Naske. The first part of the serial is devoted to the Witkowitz works. Ills. 4000 w. Serial. 1st part. Stahl u Eisen—Nov. 13, 1907. No. 88833 D.

See also Electric Driving, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Wyoming.

The Iron Ores and System of Mining at Sunrise Mine, Wyoming. B. W. Val-

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lat. From *Pro. Colo. Sci Soc.* Describes the deposits and their development. 2500 w. Min Rept—Nov. 28, 1907. No. 88663.

LEAD AND ZINC.

British Columbia.

The Duncan Section of the Lardeau Country, North Kootenay. E. Jacobs. Illustrated article describing the topography, geology, physiography, etc. 6000 w. B C Min Rec—Oct., 1907. No. 88676 B.

The St. Eugene Silver-Lead Mine, British Columbia. Ralph Stokes. Describes the deposits and methods of mining and milling. 2500 w. Min Wld—Nov. 30, 1907. No. 88667.

Gangue.

Gangue and Associated Minerals of Lead and Zinc. Otto Ruhl. Special reference to the deposits of the Missouri-Kansas fields. 1600 w. Min Sci—Dec. 19, 1907. No. 89112.

Joplin District.

Costs of Mining Operations in Joplin District. Presented at meeting of Am. Min. Cong. Gives estimates of costs with explanatory notes. 1200 w. Min Rept—Dec. 5, 1907. No. 88764.

Mining Sheet Ground in the Joplin District. Doss Brittain. Describes the drifting and stoping, breaking the ore, handling, etc. 1400 w. Eng & Min Jour—Dec. 14, 1907. No. 89016.

The Relation of Ores to Mining in the Joplin District. Otto Ruhl. Outlines the conditions governing classification. 2000 w. Min Rept—Nov. 28, 1907. No. 88664.

Lead Smelting.

Lead Smelting in Utah. Robert B. Brinsmade. A description of the methods used at the plants at Bingham Junction and at Murray. Ills. 5000 w. Mines & Min—Dec., 1907. No. 88678 C.

Leadville Geology.

Structural Geology at Leadville. F. L. Barker. A study of the formations and the structural problems. Ills. 3000 w. Mines & Min—Dec., 1907. No. 88679 C.

Milling.

See Zinc Milling, under ORE DRESSING AND CONCENTRATION.

Missouri.

Lead and Zinc Deposits of the Ozark Region. E. R. Buckley. Extract from the report of Directors of Missouri Bureau of Geology and Mines. 2200 w. Min Wld—Nov. 30, 1907. No. 88668.

See also Gangue and Joplin District, under LEAD AND ZINC.

Nevada.

The Silver-Lead Mines of Eureka, Nevada. Walter Renton Ingalls. Illustrated account of an old mining district now being reopened. 5000 w. Eng & Min Jour—Dec. 7, 1907. No. 88912.

MINOR MINERALS.

Aluminium.

The Actual State of the Aluminium Industry (Etat Actuel de l'Industrie de l'Aluminium). Robert Pitaval. The first part of the serial gives a historical review of the industry and begins a description of the process of manufacture. Ills. 5000 w. Serial. 1st part. Génie Civil—Nov. 16, 1907. No. 88826 D.

Antimony.

Antimony: Its Use and Treatment. F. T. Havard. Classifies the different kinds of ores, and describes the various processes used for the extraction of the metal. 1500 w. N Z Mines Rec—Oct. 16, 1907. No. 89158 B.

Cadmium.

Metallic Cadmium (Ueber das Metallische Cadmium). Paul Speier. Production, uses, statistics, prices, etc. 2000 w. Oest Zeitschr f Berg u Hüttenwesen—Nov. 30, 1907. No. 88836 D.

Cobalt.

See Alloys, under COPPER.

Diamonds.

Diamond Mining. Henry Leffmann. Abstract of a lecture giving a review of methods of mining and the cutting of the stones. 2000 w. Jour Fr Inst—Dec., 1907. No. 88921 D.

Emery.

Turkish Emery Ore. E. L. Harris. Brief description of the deposits. 600 w. Min Wld—Dec. 28, 1907. No. 89235.

Gypsum.

Extent and Importance of Oklahoma Gypsum Deposits. Charles N. Gould. Describes the geology, mode of occurrence and quality of the deposits, discussing present and possible development. 1500 w. Min Sci—Dec. 12, 1907. Serial. 1st part. No. 89058.

See also Plaster of Paris, under MINOR MINERALS.

Monazite.

Mining and Cleaning Monazite. Douglas B. Sterrett. Describes methods of working the gravel deposits, the cleaning by electrical machinery, etc. 1400 w. Min Wld—Dec. 28, 1907. No. 89233.

Natural Gas.

See Anticlinal Structure, under MISCELLANY.

Nickel.

The Development of the Nickel Deposits of New Caledonia (Die Aufschliessung der Nickelerzlagerstätten in Neukaledonien). G. Dietrich. Geology, mining methods, transportation, etc. Ills. Serial. 1st part. 8200 w. Zeitschr d Ver Deutscher Ing—Nov. 16, 1907. No. 88-870 D.

Nickel Determination.

A New Method for the Determination

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of Nickel and Its Application to the Separation of Nickel from Iron, Aluminium, Zinc and Cobalt (Eine Neue Bestimmungs-methode des Nickels und ihre Anwendung in der Analyse zur Trennung des Nickels vom Eisen, Aluminium, Zink und Kobalt). Hermann Grossmann and Bernhard Schück. 2000 w. Oest Zeitschr f Berg u Hüttenwesen—Nov. 23, 1907. No. 88835 D.

Oil.

See Anticlinal Structure, under MISCELLANY.

Plaster of Paris.

Investigations on Plaster of Paris (Essais sur le Plâtre). E. Leduc and Maurice Pellet. A description of tests on the influence of various factors, fineness of material, water content, etc., on the quality of plaster of Paris, with tables of results. Ills. 7000 w. Bul du Lab d' Essais—Nov. 11, 1907. No. 88888 F.

Silica Sand.

The Silica Sand Industry. Beverley S. Randolph. An account of the sources of supply, preparation, etc. 1500 w. Eng & Min Jour—Dec. 28, 1907. No. 89214.

Sulphur.

An Improved Method of Mining Sulphur. Herman Frasch. Illustrated description of an invention relating to the obtaining of sulphur from an underground deposit by melting the sulphur and removing it in the melted condition. 3000 w. Min Wld—Dec. 14, 1907. No. 89004.

MINING.

Cableways.

See same title, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Compressed Air.

Applications of Compressed Air to Mining. Jos. H. Hart. On the importance of a good and efficient air compression plant, and some of the problems connected with its use. 2000 w. Min Wld—Dec. 21, 1907. No. 89116.

Drilling.

Testing Placer Ground with the Keystone Drill. John Power Hutchins. Illustrates and describes methods explaining some of the difficulties. 5000 w. Eng & Min Jour—Dec. 21, 1907. No. 89099.

A-B-C of Steam Percussion Drill Practice. John Power Hutchins. Suggestions for unloading, moving and setting up Keystone drills used in testing placer ground in California. Ills. 3500 w. Eng & Min Jour—Dec. 14, 1907. No. 89015.

Notes on Churn Drill Placer Prospecting. John Power Hutchins. An illustrated discussion of methods of handling core material, recording results, care of tools and equipment, etc. 4500 w. Eng & Min Jour—Dec. 28, 1907. No. 89212.

Education.

See same title, under INDUSTRIAL ECONOMY.

Electric Hoisting.

Electric Hoisting at Grangesberg, Sweden. J. B. Van Brussell. Illustrated description of plant which raises 1200 tons in eight hours. 1600 w. Eng & Min Jour—Dec. 21, 1907. No. 89100.

Electric Plants.

Some Electric Mining Operations in Belgium. Frank C. Perkins. Illustrates and describes electric plants used in coal mines. 7000 w. Min Wld—Nov. 30, 1907. No. 88666.

Explosives.

The Manufacture of High Explosives. Illustrates and describes the methods of work at the Nobel factory in Scotland. 3000 w. Sci Am—Dec. 28, 1907. No. 89153.

Haulage.

Underground Haulage. John Bell. Read before the British Soc. of Min. Students. Considers the main and tail rope, and the endless rope systems. 5000 w. Can Min Jour—Dec. 1, 1907. Serial. 1st part. No. 88765.

Hoisting Engines.

Stopping and Governing Devices on Steam Hoisting Engines (Stau- und Regelvorrichtungen bei Dampffördermaschinen). Herr Grunewald. A general discussion of the subject is contained in the first part of the serial. Ills. Serial. 1st part. 4500 w. Zeitschr d Ver Deutscher Ing—Nov. 2, 1907. No. 88867.

See also Electric Hoisting, under MINING.

Mine Dam.

An Emergency Water Supply for a Coal Breaker. John H. Haertter. Describes a successful experiment to avert suspension for need of water, by constructing a mine dam. 1500 w. Eng & Min Jour—Dec. 14, 1907. No. 89018.

Mine Temperature.

The Influence of High Temperatures on the Output of the Workers in Saltpeter Mines (Ueber den Einfluss höherer Temperaturen in Kalisalzgruben auf die Leistung der Arbeiter). Herr Barnitzke. A record of extensive observations. Ills. 5500 w. Glückauf—Nov. 9, 1907. No. 88838 D.

Ore Handling.

Labor-Saving Appliances at the Mines of the New Kleinfontein Co., Transvaal. Edward J. Way. Illustrated description of appliances installed, and a report of the cost reduction effected. 7000 w. Inst of Mech Engrs—Nov. 15, 1907. No. 88710 N.

See also Nickel, under MINOR MINERALS.

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Quarrying.

Granite Quarrying. T. Nelson Dale. Brief discussion of methods used, utilization of waste, etc. 1400 w. Min Wld—Dec. 28, 1907. No. 89232.

Quarry Plant.

A Modern Quarry Plant. Illustrated description of a plant in England. 1700 w. Engr, Lond—Dec. 13, 1907. No. 89139 A.

Stoping.

Methods of Stoping at Cripple Creek. G. E. Walcott. Describes the methods and gives a comparison of costs. 2500 w. Eng & Min Jour—Nov. 30, 1907. No. 88652.

Stowing.

Waste Stowing Plant at the Deutscher Kaiser Mine at Hamborn (Spülversatzanlagen auf Zeche Deutscher Kaiser bei Hamborn). Illustrated description of a plant for stowing the mine with sand from blast-furnace slag, with details of operation. 3200 w. Glückauf—Nov. 2, 1907. No. 88837 D.

Timbering.

Substitution of Steel for Timber in Mines. R. B. Woodworth. Abstract of a report made to the Carnegie Steel Co. An investigation of the timber conditions in the anthracite region. Ills. 4500 w. Mines & Min—Dec., 1907. No. 88677 C.

See also Wyoming, under COAL AND COKE.

Tunnels.

See same title, under CIVIL ENGINEERING, CONSTRUCTION.

Ventilation.

Notes on the Ventilation of Deep Mines (Einige Betrachtungen über die Erzeugung des Wetterstromes in tiefen Gruben). K. Kegel. Discusses theoretically the influence of changes of temperature, humidity, etc. 2000 w. Glückauf—Nov. 16, 1907. No. 88840 D.

ORE DRESSING AND CONCENTRATION.

Concentration.

See Monazite, under MINOR MINERALS.

Copper.

The Utah Copper Company's Garfield Plant. Illustrated description of a 6000-ton capacity concentrating mill and accessory power house. 1200 w. Min Sci—Dec. 12, 1907. No. 89056.

Elmore Process.

The Elmore Vacuum Process at Dolcoath. Edward Walker. An illustrated account of the successful treatment of the complex tin-copper tungsten ores of Cornwall. 1500 w. Eng & Min Jour—Dec. 14, 1907. No. 89014.

Magnetic Separation.

See Monazite, under MINOR MINERALS.

Zinc Milling.

Milling Practice at Gundling No. 5, Joplin District. Doss Brittain. An illustrated description of method of treating ore which is mainly zinc sulphide. 2200 w. Min Wld—Dec. 14, 1907. No. 89003.

MISCELLANY.

Alloys.

The Actual State of the Theories on the Equilibrium of the Iron-Carbon System (Etat Actuel des Théories sur l'Equilibre du Système Fer-Carbone). M. A. Portevin. A comparative review of the theories, drawing conclusions. Ills. 5500 w. Rev. de Métal—Nov., 1907. No. 88816 E + F.

Anticlinal Structure.

Relation of Anticlinal Structures to Gas, Oil and Water. Arthur Lakes. An illustrated study. 1000 w. Min Sci—Dec. 19, 1907. No. 89113.

Faulting.

Faulting in the Red Cloud Mine. H. W. Turner. Describes conditions found in these lead-silver mines in Idaho. 1500 w. Min & Sci Pr—Dec. 14, 1907. No. 89065.

Klondike Geology.

The Geology of the Klondike. Dr. Willis Eugene Everette. Describes geological investigations of the rocks of the Yukon River. 4000 w. Sci Am Sup—Dec. 28, 1907. Serial, 1st part. No. 89156.

New South Wales.

Minerals and Metals in New South Wales. F. Danvers Power. Gives a list of minerals found and the uses to which they may be applied. 6500 w. Aust Min Stand—Oct. 30, and Nov. 6, 1907. Serial, 2 parts. No. 89027 each B.

Norway.

Mining in Norway. Joseph Ralph. An account of the mining outlook, labor conditions, etc., in the present number. 3000 w. Min Jour—Nov. 30, 1907. Serial, 1st part. No. 88959 A.

Oklahoma.

Mineral Resources of Oklahoma. Charles N. Gould. Information concerning deposits of coal, oil, gas, rock asphalt, salt, gypsum, etc. 2000 w. Mfrs Rec—Dec. 5, 1907. No. 88726.

Ore Deposits.

The Problem of the Metalliferous Veins. James Furman Kemp. From a presidential address before the New York Academy of Science. Discusses the Geological formation. 2200 w. Sci Am Sup—Dec. 28, 1907. Serial, 1st part. No. 89155.

Ore Genesis.

Genesis of Ores in the Light of Modern Theory. Horace V. Winchell. From a commencement address before the Montana Sch of Mines. Shows the importance of mass, time, temperature, climate, etc., as factors in enrichment. 3500 w. Eng & Min Jour—Dec. 7, 1907. No. 88914.

We supply copies of these articles. See page 878.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

The Prevention of Railway Accidents. Editorial, discussing the need of the extended adoption of the automatic engine-stop system of signalling. 1500 w. Engr, Lond—Nov. 22, 1907. No. 89270 A.

Collisions.

Fatal Railway Collisions. Description of three collisions in England, prepared from Board of Trade reports. 2000 w. Engr, Lond—Dec. 20, 1907. No. 89267 A.

Can Railroad Collisions be Reduced to a Theoretical Minimum? Harold Vinton Coes. An argument for an automatic mechanical engine-stop system. 3300 w. Engineering Magazine—Jan., 1908. No. 89181 B.

Signalling.

Block Signals in 1907. Reviews the history of the applications of signals to American railways, and the recent action by the Interstate Commerce Commission. 1600 w. Ry Age—Dec. 27, 1907. No. 89236.

See also Cab Signals, under MOTIVE POWER AND EQUIPMENT.

Trains.

The "Black Diamond" on the Lehigh. An illustrated description of this well-known train, and the country through which it passes. 1000 w. Ry & Loc Engng—Dec., 1907. No. 88682 C.

MOTIVE POWER AND EQUIPMENT.

Adhesion System.

The Hanscotte System of Adhesion Traction (Zugförderung mit mittlerer Reibschiene, Bauart Hanscotte). R. Bonnin. An illustrated description of the mechanism and its application to electric and steam railroads. 2500 w. Zeitschr d Ver Deutscher Ing—Nov. 23, 1907. No. 88874 D.

Cab Signals.

Automatic Cab-Signalling on Locomotives. J. Pigg. Illustrated detailed description of Raven's Electrical System of Cab-Signalling, with a statement of the requirements it was designed to meet. 9500 w. Inst of Elec Engrs—Oct. 17, 1907. No. 89037 N.

The Bounevialle System of Electric Signalling on Locomotives. Illustrates and describes a system that gives both visual and audible signals in the cab of the locomotive. 2000 w. Elect'n, Lond—Dec. 20, 1907. No. 89252 A.

Couplings.

The Strength of a Steam Locomotive Coupling (Die Beanspruchung der Kupplung einer Dampflokomotive). Herr Strahl. A mathematical and general discussion of the stresses to which the coupling between tender and locomotive is subjected. Ills. 6500 w. Glasers Ann—Nov. 1, 1907. No. 88859 D.

Electrification.

The Electrification of the Swedish State Railways. Gives an abstract of the report, prepared by Robert Dahlander, as the basis of a scheme for the whole country, with two exceptions. 4200 w. Engng—Dec. 13, 1907. No. 89136 A.

An Investigation of Steam Railroad Electrification, with Particular Reference to the Suburban Lines at Melbourne, Victoria. Thomas Tait. Abstract of a recent report showing the progress and results. Also editorial, map. 9000 w. R R Gaz—Dec. 13, 1907. No. 88940.

Fuel.

The Influence of Heat Value and Distribution on Railway Fuel Cost. J. G. Crawford. Deals with the economical purchase and supply of coal. Also discussion. 10500 w. Pro W Ry Club—Nov. 19, 1907. No. 89163 C.

Locomotive Chimneys.

Trials, with Chimneys and Blast-Pipes on Locomotives. E. Höhn. Brief report of trials. 1000 w. Bul Int Ry Cong—Nov., 1907. No. 89196 E.

Locomotive Repairs.

See Shops, under MOTIVE POWER AND EQUIPMENT.

Locomotives.

Four-Wheel Shunting Tender Locomotive. Brief illustrated description. 400 w. Engng—Dec. 20, 1907. No. 89257 A.

Tandem Compound Engine with Bollinckx Valve-Gear. Plate and description. 1000 w. Engng—Dec. 20, 1907. No. 89258 A.

Tank Locomotive for the Midland Railway. Illustrated detailed description of an English engine for long distance running. 800 w. R R Gaz—Nov. 29, 1907. No. 88644.

Ten-Wheel Locomotive for General Service. Illustrated description of class D-3-B locomotive for the Delaware & Hudson Co. 800 w. Am Engr & R R Jour—Dec., 1907. No. 88783 C.

Four-Cylinder de Glehn Compound Locomotive for the Paris-Orleans Railway of France. Illustrated detailed description of American built engines. 900 w. Ry Age—Nov. 29, 1907. No. 88671.

We supply copies of these articles. See page 878.

Atlantic Type Passenger Locomotive for the North British Railway Company. Illustrated detailed description of engines for heavy express service. Plate. 900 w. Engng—Dec. 6, 1907. No. 89052 A.

Locomotive for the G. I. P. Railway. Plate and description of one of the latest types of locomotives introduced into India for fast mail and passenger traffic. 400 w. Engr, Lond—Dec. 13, 1907. No. 89138 A.

Locomotives for South Manchurian Railroads. Illustrates and describes a type of which twenty consolidation locomotives for freight service have been built in America. Also two steam inspection cars. 500 w. R R Gaz—Dec. 6, 1907. No. 88903.

4-5 Coupled, Compound Freight Locomotive of the Italian State Railway (4-5 gekuppelte Verbund Güterzuglokomotive der Italienischen Stattsbahn). G. Heise. Illustrated detailed description. 1600 w. Zeitschr d Ver Deutscher Ing—Nov. 30, 1907. No. 88875 D.

The Four-Cylinder Compound Locomotive, Series C 4-5, with Four Coupled Axles, of the Gothard Railway (Die Vierzylinder-Verbund-Lokomotive met vier gekupperten Achsen, Series C 4-5, der Gotthardbahn). Illustrated description. 2500 w. Schweiz Bau—Nov. 9, 1907. No. 88842 B.

Locomotive Stokers.

Mechanical Stoking on Locomotives and Marine Boilers. C. S. Vesey-Brown. Discusses some of the latest methods of stoking by mechanical appliances. Ills. 3000 w. Cassier's Mag—Dec., 1907. No. 88981 B.

Shops.

The Readville Locomotive Repair Shops. Illustrated description of a N Y, N H, & H R R improvement. 4000 w. Ir Age—Dec. 5, 1907. No. 88782.

The Harmon Shops for the New York Central Electric Zone. Illustrated detailed description. 2500 w. Ry Age—Dec. 13, 1907. No. 89001.

Some Engineering Features of the Parsons Shops of the Missouri, Kansas & Texas Ry. Illustrates and describes features of the locomotive and repair shops at Parsons, Kans. 4500 w. Eng Rec—Dec. 7, 1907. No. 88769.

The Beech Grove Shops of the Big Four. Reviews the conditions affecting the planning of this Indiana plant, and describes the grouping and operating arrangements. Ills. 3500 w. R R Gaz—Nov. 29, 1907. No. 88646.

Smoke Consuming.

The Smoke Consuming Question Forty-eight Years Ago. C. H. Caruthers. An illustrated account of a series of trials made on the Pennsylvania R R in 1859. 6000 w. R R Gaz—Dec. 13, 1907. No. 88942.

Steam vs. Electricity.

See Interurban, under STEAM AND ELECTRIC RAILWAYS.

Superheating.

Test of Vauclain Superheater on the Rock Island. Illustrations, with account of tests. 1800 w. Ry Age—Dec. 13, 1907. No. 89000.

Train Lighting.

The Evolution of the Lighting of Passenger Carriages on the Prussian and Hessian State Railways. Mr. Wedler. Gives a short sketch of lighting methods formerly used and describes the new system introduced. Ills. 3500 w. Bul Int Ry Cong—Nov., 1907. No. 89195 E.

Wheel Contacts.

Areas of Contact Between Wheels and Rails. George L. Fowler. Reprinted from a volume of reports made to the Schoen Steel Co. describing an extensive series of tests. Ills. 2000 w. R R Gaz—Dec. 20, 1907. No. 89077.

Wheel Friction.

Co-efficients of Friction Between Wheels and Rails. George L. Fowler. From a volume of reports made to the Schoen Steel Wheel Co. Gives results of experimental investigations of the causes of slipping. 2500 w. R R Gaz—Dec. 27, 1907. No. 89171.

Wrecking Outfits.

The Organization and Working of Wrecking Outfits. A committee report presented to the Chicago convention of the Roadmasters' and Maintenance of Way Assn. 1000 w. R R Gaz—Dec. 20, 1907. No. 89076.

NEW PROJECTS.

Congo.

The Congo Railroad. Brief account of its construction and operation. 1200 w. R R Gaz—Dec. 13, 1907. No. 88939.

PERMANENT WAY AND BUILDINGS.

Car Dumping.

See same title, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Clearing.

Methods and Cost of Clearing and Grubbing Land. Describes work in connection with railroad construction. 1800 w. Engng-Con—Dec. 25, 1907. No. 89145.

Crossing Gates.

An Electrically-Operated Automatic Railway Gate (Una Nuova Barriera Ferroviaria Automatica a Comando Elettrico). Emilio Gerli. Illustrated description. 2000 w. Ing Ferroviaria—Nov. 16, 1907. No. 88802 D.

Crossings.

Grade Crossing Abolition at Newton

We supply copies of these articles. See page 878.

Highlands and Newton Centre, Mass. Walter C. Whitney. Illustrated description of recent work on the B & A R R. 5000 w. Eng Rec—Nov. 30, 1907. No. 88656.

Earth Slides.

Controlling Earth Slides. H. Rohwer. Reprint from Bul No 90 of the Am Ry Engng & Main of Way Assn. Describes work showing the importance of thorough drainage in maintaining a good roadbed. Ills. 2000 w. R R Gaz—Dec. 13, 1907. No. 88943.

Improvements.

Southern Pacific Improvements. Brief illustrated description of important changes to better traffic conditions. 1200 w. Eng Rec—Dec. 14, 1907. No. 89008.

Roadbed and Terminal Improvements, Baltimore & Ohio R R. Describes the recent revision of the main line between Hollofields and Davis, Md. Ills. 2500 w. Ry & Engng Rev—Dec. 28, 1907. No. 89238.

Vandalia Track Elevation and Improvement Work at Indianapolis. Map and illustrated description of serious and puzzling problems solved in work made necessary by track elevation ordinance requirements. 2000 w. R R Gaz—Dec. 27, 1907. No. 89169.

Rails.

The Sandberg Rail. An account of these high silicon rails, with report of tests. 2500 w. Tram & Ry Wld—Dec. 5, 1907. No. 89046 B.

Rail Specifications. Gives the full majority report of the American Ry Assn, with extracts from other specifications, Hollofields and Davis, Md. Ills. 2500 w. R R Gaz—Dec. 20, 1907. No. 89074.

Steel Rails. Franklin E. Abbott. Gives outline description of the process of manufacture and discusses their use from the utilitarian point of view. 11500 w. Pro Cent Ry Club—Nov. 8, 1907. No. 89162 C.

Reconstruction.

Double Tracking Through Eagle River Canyon on the Denver & Rio Grande. Illustrated description of work costing more than $100,000 a mile. 1000 w. R R Gaz—Dec. 13, 1907. No. 88941.

Shops.

See same title, under MOTIVE POWER AND EQUIPMENT.

Stations.

The New Union Station at Washington, D C. Illustrated detailed description. 3000 w. Engr, Lond—Nov. 29, 1907. No. 88964 A.

Passenger Stations and Train Yards in the United States. E. Giese and Dr. Blum. Plans and descriptions of recently designed stations and yards. 16000 w. Bul Int Ry Cong—Nov., 1907. No. 89198 E.

Terminals.

The New Locomotive Terminal of the Chicago Junction. Illustrated description. 1000 w. R R Gaz—Dec. 20, 1907. No. 89075.

The Bush Terminal Company. Describes the work accomplished at this deep water terminal in South Brooklyn, and the plant and methods. 1800 w. R R Gaz—Dec. 27, 1907. No. 89172.

Track Construction.

Prussian Railroad Tests. William Mayner. A synopsis of Prof. Frahm's report of the official experiments on the trial track at Oranienburg. 1200 w. Sci Am Sup—Dec. 14, 1907. No. 88952.

Tunnels.

See same title, under CIVIL ENGINEERING, CONSTRUCTION.

Yards.

The New Shunting Yard at Mannheim. Plan and description. 1200 w. Bul Int Ry Cong—Nov., 1907. No. 89199 E.

TRAFFIC.

Agreement.

The Great Northern and Great Central Agreement. Discusses the proposed working agreement. 2000 w. Engr, Lond—Dec. 20, 1907. No. 89265 A.

Car Hire.

"Per Diem" Suspended in New England. An account of the controversy over the rate per diem for car hire between the principal roads in New England and the rest of the country. 2800 w. Ry Age—Dec. 13, 1907. No. 88999.

Demurrage.

Digest of Reciprocal Demurrage Laws. Compiled by the American Railway Clearing House. 2000 w. Ry Age—Nov. 29, 1907. No. 88672.

M. H. Smith on Excess of Traffic Over Facilities in Alabama. From a statement to the Committee of the Alabama Legislature on reciprocal demurrage. 1000 w. R R Gaz—Dec. 27, 1907. No. 89173.

Locomotive Pooling.

Pooling of Locomotives in General. D. R. McBain. Read at Trav Engrs' Con. Gives reasons why pooling is necessary and how to make it a success. 2000 w. Ry & Loc Engng—Dec., 1907. No. 88684 C.

Refrigeration.

Recent Investigations in the Handling of Perishable Products for Transportation. S. J. Dennis. Discusses results of experiments made by the Dept. of Agriculture to determine the bearing of different methods of handling and shipping. 3000 w. Ice & Refrig—Dec., 1907. No. 89026 C.

We supply copies of these articles. See page 878.

Wastes.

Wastes of Fuel, Power and Time in Railroad Operation. D. C. Buell. From a paper presented to the Trav Engrs Assn. Calls attention to channels through which energy is wasted. Also causes of waste of time. 2200 w. R R Gaz—Dec. 6, 1907. No. 88904.

MISCELLANY.

Africa.

Railway Progress in the Dark Continent. J. Hartley Knight. An illustrated account of recent projects and their progress. 3000 w. Engineering Magazine—Jan., 1908. No. 89180 B.

England.

Transportation in England (Die Engländer und ihr Verkehrswesen). Herr Frahm. A general review of railway conditions and organization in Great Britain. Ills. 7500 w. Glasers Ann—Nov. 15, 1907. No. 88861 D.

Railway Problems.

Symposium on Railway Conditions and Problems. Gives responses received to a letter sent out asking for views on present conditions. 22000 w. Ry Age—Dec. 27, 1907. No. 89237.

St. Gothard.

Silver Wedding of the St. Gothard Railway. W. Berdrow. A review of the history of the road for twenty-five years. 5500 w. Bul Int Ry Cong—Nov., 1907 No. 89197 E.

Train Ferry.

See same title, under MARINE AND NAVAL ENGINEERING.

STREET AND ELECTRIC RAILWAYS

Adhesion System.

See same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Axles.

Broken Axles. W. Park. Discusses the principal causes of axle breakage. 2000 w. Tram & Ry Wld—Dec. 5, 1907. No. 89047 B.

Brake Tests.

Electro Mechanical Brake Tests at Leeds. An illustrated account of tests made of A. W. Maley's invention. 2500 w. Elect'n, Lond—Nov. 29, 1907. No. 88978 A.

Braking Tests in Leeds, England. Reports a series of track brake tests carried out recently. Ills. 1600 w. St Ry Jour—Jan. 4, 1908. No. 89352.

Buenos Aires.

The Lacroze Tramway System and the Buenos Aires Central Railway. Illustrated detailed description of a combined steam and electric service. 3000 w. Tram & Ry Wld—Dec. 5, 1907. No. 89045 B.

Car House.

The New Fourteenth Street Concrete Storage Car House of the Capital Traction Company, Washington. Illustrated detailed description. 3800 w. St Ry Jour Dec. 21, 1907. No. 89108.

Communication Systems.

See Composite System, under ELECTRICAL ENGINEERING, COMMUNICATION.

Controllers.

The Automatic Controller. W. B. Kouwenhoven. Illustrated description of a device which gives a uniform rate of acceleration. 3000 w. Ry & Loc Engng—Jan., 1908. No. 89339 C.

Electrification.

See same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Funeral Trains.

Electric Funeral Trains in Milan. Illustrated description of the electric car service for funerals. 1200 w. St Ry Jour—Jan. 4, 1908. No. 89351.

Instruction Sheets.

Shop Prints of the Public Service Corporation of New Jersey. Gives a series of instruction sheets on wiring, brush setting, etc., prepared for distribution among the employes. 1000 w. St Ry Jour—Dec. 14, 1907. No. 89023.

Interurban.

The Fort Dodge, Des Moines & Southern Railway. Illustrated description of this electric line and its operation. 600 w. R R Gaz—Dec. 6, 1907. No. 88901.

The Atlantic Shore Line. Illustrated description of the last link in a system in New England, with information relating to the route and operation. 4000 w. St Ry Jour—Dec. 14, 1907. No. 89022.

The Milwaukee Northern Railway. Illustrated detailed description of a line in process of construction which will ultimately connect Milwaukee and Fond du Lac. Its equipment, gas engine power, etc. 5800 w. Elec Ry Rev—Dec. 7, 1907. No. 88905.

The Easton & Washington Traction Company. Illustrated description of a

We supply copies of these articles. See page 878.

new line in the Delaware Valley, eventually to reach Lake Hopatcong. 2000 w. St Ry Jour—Dec. 28, 1907. No. 89229.

The Indianapolis & Louisville 1200-Volt Direct-Current Line. John R. Hewett. Illustrated detailed description of the scheme of electrification on the portion of the line completed. 3500 w. St Ry Jour—Jan. 4, 1908. No. 89350.

The Development of Electric Transportation Service and Its Effect on St. Louis. B. R. Stephens. Discusses the comparative efficiency of steam and electric roads, the growth of business, etc. 3500 w. Elec Ry Rev—Dec. 21, 1907. No. 89110.

Electric Railways in Sparsely Settled Communities. E. P. Roberts. Abstract of a paper read before the Am St & Int Ry Assn. Considers the requirements for success for suburban and interurban electric lines. 3000 w. R R Gaz—Dec. 27, 1907. No. 89170.

See also Single Phase, under STREET AND ELECTRIC RAILWAYS.

Locomotives.

New Locomotives for the Illinois Traction System. Illustrated detailed description. 800 w. Elec Ry Rev—Dec. 28, 1907. No. 89230.

Large Electric Locomotives for Heavy Service. Bela Valatin. A comparison of 15-cycle, single-phase locomotives and 15-cycle three-phase locomotives in weight and performance. 1500 w. St Ry Jour—Jan. 4, 1908. No. 89353.

Lotschberg.

The Lötschberg Railway (Chemin de Fer du Lötschberg). The first part of the serial discusses the various projected routes and the line finally chosen, the costs, etc. Ills. 3000 w. Bul Tech d l Suisse Rom—Nov. 25, 1907. No. 88822 D.

Motors.

See Railway Motors, under ELECTRICAL ENGINEERING, DYNAMOS AND MOTORS.

New York Subway.

See Subways, under STREET AND ELECTRIC RAILWAYS.

Single Phase.

Windsor, Essex, and Lake Shore Rapid Railway. Illustrates and describes the first single-phase electric railway to be built and operated in Canada. 2500 w. Elec Ry Rev—Dec. 21, 1907. No. 89109.

The Westinghouse System of Single-Phase Electric Traction on European Railways (La Traction Electrique par Courant Altérnatif Simple sur les Chemins de Fer en Europe, Système Westinghouse). M. Henry. Begins a complete detailed description. Ills. 2300 w. Serial, 1st part. Electricien—Nov. 16, 1907. No. 88820 D.

The New Haven System of Single-Phase Distribution with Special Reference to Sectionalization. W. S. Murray. Reviews briefly alternative systems that were considered, and discusses the methods and lengths involved in sectionalizing the single-phase distribution. 4000 w. Pro Am Inst of Elec Engrs—Jan., 1908. No. 89327 D.

Brembana Valley Single-Phase Railway. Illustrated description of a recently completed line, one of the first in Europe employing the Westinghouse single-phase system. 2200 w. Elect'n, Lond—Dec. 27, 1907. No. 89378 A.

See same title, under ELECTRICAL ENGINEERING, DYNAMOS AND MOTORS.

Subways.

Methods of Increasing the Capacity of the New York Subway. Extracts from the preliminary report of B. J. Arnold, suggesting methods of improving the service. 2500 w. Eng Rec—Dec. 7, 1907. No. 88771.

The Great Northern, Piccadilly and Brompton Electric Tube Railway in London (Die elektrisch betriebene Great Northern, Piccadilly and Brompton-Röhrenbahn in London). E. A. Ziffer. A general description of the tubes, stations, power stations, rolling stock, etc. Ills. 3500 w. Mit d Ver f d Förd d Lokal u Strassenbahnwesens—Oct., 1907. No. 88829 F.

Subway Stations.

An arched Station of Reinforced and Hooped Concrete on the Considère System (Station voutée en Béton armé et fretté du Système Considère). Henry Lossier. An illustrated detailed description of the design of one of the stations of the Paris Subway. 2500 w. Beton u Eisen—Nov. 1907. No. 88866 F.

Third Rail.

The Third-Rail Problem. A. D. Williams, Jr. A discussion of the physical difficulties in installation and maintenance. 3800 w. Engineering Magazine—Jan., 1907. No. 89178 B.

Tokio.

The Tokio Electric Street Railway Company. Henry K. Brent. Map and account of street railway progress in this city of Japan. 3000 w. St Ry Jour—Dec. 7, 1907. No. 88763.

Wire Suspension.

A New Suspension for the Contact Wires of Electric Railways Using Sliding Bows. Joseph Mayer. Discusses the economical construction of a safe contact wire, giving formulas for calculating stresses, and describing a strain adjuster and explaining the theory. Ills. 10000 w. Pro Am Soc of Civ Engrs—Dec., 1907. No. 89226 E.

We supply copies of these articles. See page 878.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.

Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Science. *w.* Denver, U. S. A.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Technology Quarterly. *qr.* Boston, U. S. A.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Verkehrstechnische Woche und Eisenbahntechnische Zeitschrift. *w.* Berlin.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Electric Lighting.

Pocket Book of Electric Lighting and Heating. By Sydney F. Walker. Size, 6½ by 4 in.; pp., 438. Ills. Price, $3. New York: The Norman W. Henley Publishing Company.

The author of this handbook makes no claim to originality of matter. The aim has been to place in handy form for the central-station engineer and contracting engineer information as to the appliances under their control or which they may be required to furnish in an emergency which is usually contained in trade catalogues or is otherwise difficult to obtain. While it relates principally to materials of British manufacture, it should prove of value to engineers in all parts of the world. The author has included as much information as possible as to sizes, weights, efficiencies, dimensions, etc., and in this departure from the regular field of the electrical handbook has produced a very practical guide for the lighting and heating engineer. The eight sections into which the book is divided include an Introduction, on the fundamental principles of electrical engineering, and sections on Generators, Accumulators, Switch-boards, Circuit Breakers, Cables, Measuring Instruments, Lamps and Accessories, and Heating Appliances.

Management.

Works' Organization, Accounting, and Cost Systems of the firm of Ludw. Loewe & Co., Berlin. (Fabrikorganisation, Fabrikbuchführung und Selbstkostenberechnung der Firma Ludw. Loewe & Co.). By J. Lilienthal. Size, 10½ by 7½ in.; pp., 220. Ills. Price, M. 10. Berlin: Julius Springer.

A complete exposition of the management system of this important German firm, thoroughly illustrating the forms and methods used in accounting and cost keeping. As an exemplification of the best current Continental practice in works' management and organization, the book can be recommended to the attention of anyone interested in the problems of systematizing and cheapening production in industrial operations.

Specifications.

Specifications and Contracts. By J. A. L. Waddell and John C. Wait. Size, 9 by 6 in.; pp., 169. Price, $1. New York: The Engineering News Publishing Company.

This excellent little book contains reprints of Dr. Waddell's lectures on "Specifications" and "Engineering Contracts," delivered before the engineering students of the Rensselaer Polytechnic Institute, supplemented by a large amount of new matter giving examples for practice in the drawing of specifications and contracts and a "Note on the Law of Contracts" by Mr. John C. Wait. *Engineering News* has done students of engineering a distinct service in publishing in such convenient form so interesting and authoritative a discussion of these important subjects.

BOOKS RECEIVED.

The "Mechanical World" Electrical Pocketbook for 1908. Size, 6 by 4 in.; pp., 247. Ills. Price, 6d. Manchester: Emmett & Co., Limited.

Moving Loads on Railway Underbridges. By H. Bamford. 8 by 6½ in.; pp., 78. Ills. Price, $1.25. New York: The Macmillan Company. London: Whittaker & Co.

Annuaire pour l'An 1908 publié par le Bureau des Longitudes. Avec des Notices Scientifiques. Size, 6 by 4 in.; pp., 958. Ills. Price, 1 fr. 50 c. Paris: Gauthier-Villars.

Coal-Mine Accidents: their Causes and Prevention. By Clarence Hall and Walter O. Snelling. Size, 9 by 6 in.; pp., 21. Washington, D. C.: United States Geological Survey.

Annual Report of the Chief of the Bureau of Steam Engineering to the Secretary of the Navy for the Fiscal Year 1907. Size, 9 by 6 in.; pp., 56. Washington, D. C.: Navy Department.

The State of Wyoming. A Book of Reliable Information Published by Authority of the Ninth Legislature. Size, 9 by 6 in.; pp., 141. Ills. Cheyenne, Wyo.: Commissioner of Public Lands.

The Hardening Process of Hydraulic Cements. By Dr. W. Michaelis, Sr. Translated by Dr. W. Michaelis, Jr. Size, 8 by 5½ in.; pp., 29. Price, 50 cents. Chicago, Ill.: Cement & Engineering News.